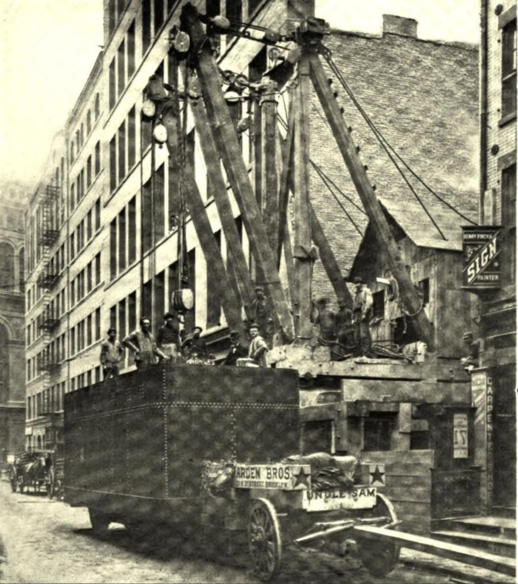

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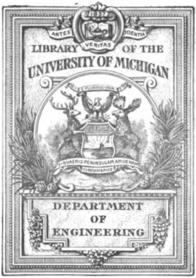
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THE

ENGINEERING MAGAZINE

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THE SIGNIFICANCE OF OUR EXPANDING EXPORT TRADE.

By Thomas A. Eddy.

THE increase in our exportation of manufactured goods for 1896 is without a parallel in the history of American commerce, being an advance of $45,000,000 beyond that of 1895. And not only is the sum of this exportation—$228,571,000—by far the greatest, but the ratio of of exports of manufactures to all our other exports is also by far the highest yet reached—more than 26 per cent.

This development is of inestimable importance, to American engineers especially, because where American manufactures—and especially American machines and tools, which constitute a large proportion of our exports—are introduced, American practice, superintendence, and exploitation naturally follow. The debt of the manufacturer to the engineer, for both direct and indirect assistance in the expansion of trade, has often been pointed out. It needs to be recognized that there is a converse to the proposition.

The development of mining, of railroad building, of electric-traction, power, and light installations, and of civil, municipal, sanitary, electrical, and mechanical engineering work of every character, is but in its infancy in the newer countries of the world. The entry of our manufactures and machinery in their markets is the key which will open almost limitless room for American engineering enterprise and engineers.

The United States has long held a commanding position in the exportation of agricultural products, but the building up of the outland trade in manufactures has been a work of time and infinite persistence in overcoming great natural and artificial obstacles. The surplus cap-

ital of Europe, instead of being invested at home at low rates of interest, seeks employment abroad, and has been largely instrumental in developing the export trade of the countries on the other side of the Atlantic, whose bankers regard as one of the most lucrative branches of their business the furnishing to their merchants of credit facilities for foreign trade; and these facilities they provide on terms so liberal that relatively small capital can control large undertakings. They naturally provide first for their own countrymen, with whose methods, resources, and operations they are familiar, and over whom they can exercise control.

American merchants and manufacturers, wishing to do foreign business on a large scale must, in addition to their own capital, utilize such surplus facilities as the foreign banker can devote to their necessities, after reserving the resources required to care for his nearer friends. In the absence of American banks abroad, our foreign trade is dependent on the amount of credits we can secure from European agencies. The English and European banks and bankers have so admirably organized their branches or agencies, throughout the world, that, under present conditions, we must use their facilities; and they receive a commission upon every shipment of American merchandise, whether to South America, South Africa, or the east. We need an American international bank.

With our large demand for the raw materials produced by other countries, such as coffee, rubber, sugar, hides, and wool, from South America, and the products of the far east, we have a basis of exchange to warrant the establishment of an American bank having branches in all important trade centers in South America, and agencies in Australia, South Africa, Japan, China, and India. With such a bank extending its influence to the far parts of the world, furnishing credit facilities for the exchange of American products for those of other countries, and always in touch with each transaction, we should transfer to American pockets the millions now paid to foreign bankers in the shape of commissions and interest, and be brought in touch with the industrial enterprise of new countries. It would enable American capitalists and contractors to undertake the building of steam and electric railways, docks, bridges, piers, and other public works, and, consequently, enormously broaden the field for our manufactured goods. The excess of our exports over imports would become a permanent feature of our statistics, making certain the annual flow of gold to the United States, every dollar of it representing a profit from which we are now shut out.

In the congress of all the American republics held a few years ago in Washington, chiefly for the purpose of developing more inti-

mate trade relations between the peoples of this continent, a resolution was unanimously adopted recommending to the governments represented the establishment of an International American Bank, under an act of congress of the United States, with branches in all the republics of Central and South America. Without such a system large trade operations in foreign countries are impossible. The commerce of Great Britain is most efficiently sustained by a net-work of banking-houses and agencies covering the whole world of trade, and directed from London. In London there are no less than sixty incorporated banks having for their sole function the conduct of international finance as related to commerce; these banks are concerned with international trade exclusively, and have nothing to do with the finances of governments.

The capital and surplus of these international banking-houses of London are nearly five times as great as those of the national banks of New York, the commercial center of America. The capital of those sixty London banks amounts to nearly $300,000,000, with surplus of $70,000,000, and their deposits exceed $1,200,000,000. Nor is that all. There are in London private banking-houses, with capital aggregating over $175,000,000, which give material aid to the foreign trade of the kingdom. The vast foreign trade of Great Britain, amounting to more than three thousand million dollars a year, is financed easily and safely by this admirable system of banks, branches, and agencies; and not the British foreign trade alone, but the larger part of the foreign trade of all other countries, including our own.

Of England's international banking capital, one hundred million dollars sustains and facilitates her commercial transactions with the United States and Canada. The products of the republics of South America are brought to market with the aid of eighty million dollars of British capital, whatever their destination may be; naturally the chief destination is England. The American importer of coffee or rubber from Brazil pays tribute to a London banker. To the trade of China and Japan with the rest of the world, twenty-five million dollars of British capital affords the ways and means, without which the opening of their ports to the western world would be a nullity. On the continent of Europe the English banking capital employed in financing trade equals the whole capital and surplus of the national banks of the great city of New York. About seventeen hundred branches and agencies are the organs of communication between the banks in London and their clients all over the world—just about half the number of the national banks in the United States; the capital of those London banks is considerably more than half as large as the authorized capital of all our 3,667 national banks. The advantage thus

secured to the British merchant over his competitors is patent. The British merchant or manufacturer may draw against a shipment to any part of the globe, and cash the draft at once, while an American merchant or manufacturer must be his own banker, if he engages in foreign trade, unless he has an established footing in London, in which case he may avail himself of English facilities.

Again, our foreign commerce is urgently in need of proper shipping facilities—such shipping facilities as can be afforded only by regular lines of fast steamers. European governments have given proof of their desire to assist their merchants in developing foreign commerce, in the very liberal subsidies granted to vessels carrying their flags and trading with foreign countries; they recognize the fact that every penny's worth of merchandise exported represents that much wealth given by the foreigner in exchange for the product of their home industries; and they wisely provide the means of effecting that exchange by subsidizing steamship lines. Whenever similar aids are asked of congress on behalf of American commercial and shipping interests, a wide difference of opinion is seen to exist regarding the principle that "trade follows the flag." Speaking from an experience of twenty-five years, I can affirm the truth of the proposition, provided the measure of protection extended to the "flag"—*i. e.*, to the mercantile marine carrying the flag—is sufficient to warrant a swift and regular service. American ship-owners have had to compete for foreign carrying-trade on a free-trade basis, against the protected lines of foreign countries, and have gradually seen their ocean tonnage shrink almost to the vanishing-point.

Notwithstanding the statement so often published that she pays no subsidies, Great Britain has been generous in mail contracts and naval subventions where they were needed for the development of her commerce. She pays no subsidies for her Indian, Australian, or South African service, it is true, but it must be borne in mind that the Indian government has for years paid heavy subsidies to English steamship companies, while South Africa, the Australian colonies, New Zealand, and Tasmania have contributed liberally to secure swift and regular service. Canada pays, through the subsidized Canadian Pacific Railroad, for maintaining a fine service to Japan and China. It is only since congress authorized mail subsidies to certain American steamship lines that we have seen our flag with increasing frequency in foreign ports.

Our shipping should be protected, to give our export trade full development, and to remove one of its most serious disabilities—the lack of proper communication with the markets. An efficiently-protected mercantile marine would return to our ship-owners, for ex-

penditure in the United States, the millions we now pay to have our goods carried to our customers abroad. *

With his command of credits, and fast steamship communication with his foreign markets,—advantages which he has enjoyed for years past,—the European merchant has been able so to entrench himself in the non-manufacturing countries of the world that it has been most difficult to assault his position. English houses have their branches and agencies in those markets, working in perfect accord with the bankers and steamship lines. They have so perfected all facilities that it requires something more than the cheapness and adaptability of merchandise manufactured in the United States to overcome the competition of this long-established trade. We cannot always win on the merits of our goods; we must be able to offer as great conveniences for trade as our competitors.

Despite these disadvantages, our export trade in manufactured goods has slowly grown, until, in the year just passed, it has reached unexampled proportions; and, having reduced the manufacture of

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* We are glad to afford Mr. Eddy the opportunity to state the case for shipping subsidies so clearly and so forcibly, but, far from sympathizing with his view, we are earnestly opposed to it. The plain English of a shipping subsidy, to our thinking, is to vote the people's money into the pockets of a few ship-owners. And whereas honest men may differ as to the wisdom of that governmental policy, there can be no question about the grave danger of inaugurating it at this time.

Of all countries in the world, England would be most warranted in voting subsidies to her ship-owners, and yet her statesmen do not dare to adopt that policy, simply because the English people would not tolerate it for one hour. Mr. Eddy indicates how the end is accomplished, in some measure, by indirect methods. But the reasons why British statesmen and colonial governors strive to do indirectly what they do not dare to attempt openly, are very clearly set forth in the following ominous paragraphs, taken from "Democracy and Liberty," the great work recently written by Mr. W. E. H. Lecky, the distinguished historian and Conservative member of Parliament. He says:

"The enormous increase which has taken place in the taxation of nearly every civilized country during the last forty-five years is certainly one of the most disquieting features of our time. National indebtedness has reached a point that makes the bankruptcy of many nations an almost inevitable result of any prolonged European war; and the immense burden of unproductive expenditure that is drawn from every nation for the purpose of paying the national creditors, *gives revolutionary literature a great part of its plausibility*, and *forms one of the strongest temptations to national dishonesty.*

The burden is a terrible one; but every one who will look facts in the face must recognize that the existence at each given moment of an English fleet of overwhelming power is the first and most vital condition of the security of the nation. An island Power which cannot even support its population with food; which *depends for its very existence on a vast commerce;* which from the vastness of its dominions and interests is constantly liable to be involved in dispute with other Powers, and which presents peculiar temptation to an invader, could *on no other condition maintain her independence*, and it is a healthy sign that English public opinion realizes the transcendent importance of the fact, and has more than once forced it upon politicians who were neglecting it."

Now, if the advocates of subsidies imagine that this country is exempt from the evil

various kinds of merchandise to a science, we can, in most of the articles produced from our own raw materials, compete with foreign nations. The extent of the practical success we have already attained in this direction can not be better exhibited than by quotation from an address by Prof. A. E. Outerbridge, Jr., recently delivered to the students of the University of Pennsylvania. Prof. Outerbridge says:

Two years ago an Alabama furnace sent an experimental shipment of two hundred and fifty tons of pig iron to England. This was considered an "exceptional case," and was also pronounced a visionary project, and derided as ridiculous in the extreme.

Within this brief period, says the *Manufacturers' Record*, the demonstration is complete.

"From that experimental two hundred and fifty-ton shipment this business has increased, until now there is an actual scarcity of steamer-room to handle the business offered. Orders are being booked every week for large shipments to England and to continental countries. It is difficult to rightly measure the influence of this trade upon the world's commercial interests."

From a recent statement by an officer of a leading furnace company, the foreign orders booked by that company alone amounted to about 40,000 tons, and inquiries

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portents of an enormous increase in the burden of taxation, they can gather light from the following extracts from a recent editorial in the New York *Sun*—the Democratic champion of protection, and a peerless advocate of our new navy and our new merchant marine:

THE COST OF RUNNING THIS NATION.

"The table subjoined shows the net ordinary expenditures of the Government, excluding interest, at intervals of ten years since the beginning of the century; together with the population, and the per capita of expenditure to population:

Year.	Population.	Expenditure.	Per capita.
1800	5,308,483	$ 7,400,000	$1.39
1810	7,239,881	5,300,000	.75
1820	9,633,822	13,100,000	1.36
1830	12,866,020	13,000,000	1.01
1840	17,069,453	24,100,000	1.41
1850	23,191,876	37,200,000	1.60
1860	31,443,321	60,000,000	1.91
1870	38,558,371	164,000,000	4.25
1880	50,155,783	170,000,000	3.39
1890	62,480,540	321,700,000	5.14
1895	70,000,000 (est.)	383,900,000	5.48

Adding the permanent annual appropriations to the appropriations made at the first session of the Fifty-fourth Congress for the current fiscal year, the total for this year is $515,845,194. Estimating the present population at 72,000,000, this is a tax of $7.16 for every man, woman and child in the country.

For the tremendous increase in the cost ef running the Federal Government, outside of the expenses resulting from a civil war which ended thirty-two years ago, it must be said that the Republican party is mainly responsible. It is a party of enterprise, but it has not hitherto shown itself to be a party of economy.

This tendency is the most serious problem which the Republican party, coming back into power under McKinley, will have to confront during the next four years."

A great and growing ocean-tonnage is altogether desirable, but it is neither essential to our "very existence," nor necessary to our independence; and any party which attempts to build up a merchant marine by means of subsidies or differential duties, will be driven from power as inevitably as fate. *Editor.*

under consideration between 30,000 and 40,000 tons. One of these, the same day on which this information was given, covering 5,000 tons, materialized into an order.

Pig iron has already been shipped to Liverpool, Manchester, Rotterdam, Vienna, Genoa, Trieste, Yokohama, and elsewhere abroad. These are facts not yet generally known.

Crude pig iron stands near the bottom of the list of articles involving a high degree of skilled labor. American watches, on the other hand, head the list. Yet they are exported in constantly-increasing quantities to all parts of the world.

Very recently the American consul at Bradford, England, reported as follows:

"One Bradford firm of jewellers alone has a stock of 20,000 Waltham watches. In addition, it has watches of the Elgin and other makes, and sells large numbers."

American files, made by machinery, according to the testimony of Consul Meeker, compete with English hand-made files. He mentions one order, recently sent to this country, for one thousand dozen, whereas an order for two hundred dozen English files would be considered, ordinarily, as a large one.

"Go into any cutlery or hardware shop in Bradford," said Mr. Meeker, "and ask for shears, and you will be handed a pair bearing a Newark or Trenton, N. J., imprint. They are considered superior in every way, and one of the strange things about it is that they must be purchased through Sheffield, which is supposed to be the rival of American cutlery manufacturers. These shears, a dealer said to me, are superior to all others, because they are 'sweet cutters.' The shears used by tailors and cutters are almost entirely of American make.

"Turbine water wheels and printing presses of American manufacture are also sold in Bradford."

Seven thousand tons of steel rails, besides enormous quantities of other railroad material, are now being made in Pittsburg for Japan, and large orders have, it is said, been booked for China.

A complete locomotive manufacturing plant was recently shipped from Philadelphia to Russia, and railroad machinery is now on its way from this port to Australia.

A multitude of similar illustrations could be given, but these will serve as straws to show the direction in which the "trade winds" are now blowing, and it only remains for American enterprise to take advantage of the opportunities which favorable circumstances offer to enter upon a new era of industrial prosperity.

The secret of success in these tentative experiments is to be found in the wonderful advances which have been made in labor-saving machinery, supervised by intelligent, highly-paid operatives, whereby the productive capacity of each employee is enormously increased, and the cost per unit of product correspondingly reduced.

The secret of this success lies primarily in the inventive faculty of the American people. The American manufacturer has been coining the genius of the inventor; coining the American unwillingness to walk in the ancient ways and to "leave well enough alone"; coining the ambition for some simpler, easier, and better way of producing; coining the progessiveness of the American race. He has put in practice, on the largest scale, the modern idea of bringing together under one head the resources and working-capacity of formerly competing enterprises, with the resultant economies. He has taken advantage of the specialization of work in mechanics and in the distribution of the product.

The claim for the people of the United States that they are fore-

most in mechanical ingenuity, inventiveness, business enterprise, and what might be called commercial common sense and intuition, rests, not on sentiment, but on facts patent and confessed on all sides. Hence, were it not for the hindrances just mentioned, the products of American manufacture would easily overcome all European competition in the markets of the world. The testimony of unprejudiced observers everywhere is unanimous in allowing the superiority of American-made mechanical tools of various kinds—saws, hammers, axes, chisels, and the like—to similar European-made wares. An Australian trade journal, in frankly confessing this, concedes to certain wares made in England the palm for "solidity," but remarks that the goods "do not sell themselves," while the American articles do. But is not this faculty of "selling itself" the test of an article offered for sale? The greater expertness and alertness of American artisans is recognized by another English trade journal in telling the story of two factories owned by one firm, one being in Chicago, the other in Leeds. The wages of the workmen in Chicago were about double the wages paid to those in Leeds: but, because of the greater energy and expertness of the Chicago artisans, their product cost less than that of their fellows in the heart of the most industrial community of England. And Hiram S. Maxim, the distinguished American mechanician, for many years resident in England, says that, if a mechanic in England wants "a square that is a square," he must get one made in the United States, for "there are no squares that are square" made in England.

In other countries the product of industry is far from being as great, compared with the number of workers employed, as in the United States. Great Britain for two hundred years has been "the world's workshop"; but the manufacturing and productive power of Great Britain, compared with that of the United States, per inhabitant, is only as 1,470 to 2,000; and in the same comparison Germany counts for only 900, and France for about the same. In productive power—agricultural and mechanical—the United States equals Great Britain, Germany, and France together. The same efficiency of agricultural labor which, aided by machinery, has placed the United States at the head of all nations in the production of foodstuffs is available for conquering unquestioned pre-eminence in manufacture and in foreign commerce. The grain product of the United States, per laborer employed, is 350 bushels, but the product of Great Britain per laborer is only 119 bushels.

Tonnage in manufacture is another important item. The more tonnage produced in any given article, whether steel rails, wire, lumber, or stoves, the lower is the cost of production. Hence, by pro-

ducing an exportable surplus, we reduce the cost for domestic use. Manufacturers have for years neglected foreign markets; while developing their resources and improving their machinery under the keen competition of domestic trade, they have, almost unconsciously, reached a point where they find themselves producing at a cost which enables them to compete with the cheap hand-labor of Europe. During periods of prosperity, the demand in this country has been so great that manufacturers have looked askance at foreign trade, particularly if it involved the adaptation of a part of their plant to meet the prejudices, necessities, or conditions of foreign populations. With the coming of the periodical financial cyclone, these manufacturers have found themselves obliged to reduce their force of workmen, until finally their factories were closed and thousands thrown out of employment; while, on the other hand, the few manufacturers who have worked to develop a foreign trade, have found that, during such periods of stagnation, they have been able to keep their factories busy, or running on part time, earning enough to pay interest on their investment and depreciation of plant, while keeping their men employed on living wages, holding their force together, and maintaining their machinery in running order,—in fact, finding in export trade a haven of refuge wherein to ride out the financial storm, and be in readiness to take advantage of the first break in the weather showing the return of good times. It is an insurance policy for the manufacturer, and one which he will not let lapse, if he be wise.

We have accomplished much, but we can accomplish infinitely more. The policy of this government is distinctively protective, and shipping must be protected to the same extent as manufactures. With swift, regular communication with foreign ports, with an American bank having branches in all the important trade centers of the world, and with a desire on the part of manufacturers to produce a certain surplus above the wants of the United States for export to foreign countries, this country, which is to-day standing in the open door, can step out into the vast field of exportation of manufactured goods, and be in a position to compete on equal terms with the other nations of the world.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

VI. THE INSURANCE AND ENDOWMENT FEATURES OF DOLGEVILLE.

ALFRED DOLGE was born at Chemnitz, Saxony, December 22, 1848. He was the son of August Dolge, senior member of the firm of A. Dolge & Co., piano-makers of Leipsic. At the age of seventeen, having received a common-school education and served an apprenticeship in his father's factory, he landed at Castle Garden, with little or no money, and, after some vicissitudes, found work with Mathushek, returning to Germany in 1867. Again reaching the United States in 1868, he reëntered the employment of Mathushek, and, while retaining this situation, made some small importations of piano-hammer leather and piano wire on his own account, which resulted favorably and led to his leaving Mathushek in 1869, when he was not yet twenty-one years of age, and beginning business on his own account by marrying an estimable young lady without fortune, and setting up as importer of piano materials on a cash capital of $500, saved from his earnings and his previous ventures with German leather and wire. Seven children have been born of this early marriage, of whom five sons survive, the eldest, Rudolf, being now the junior member of the firm of A. Dolge & Son, doing business at 110–112 East Thirteenth street, New York city, and at Dolgeville, Herkimer county, New York, and rated as having a capital of $1,000,000. Alfred Dolge's first store was in Amity street, near Broadway; thence he removed in 1871 to 122 East Thirteenth street, where he remained until 1893, in which year he again removed to 110-112 East Thirteenth street.

In 1871 Dolge began the manufacture of felt in Brooklyn with four workmen, but his force had increased to fifty-three operatives when in 1874 he purchased the old tannery and with it 1000 h. p. of water power at Brockett's Bridge,—a hamlet of about a hundred inhabitants, eight miles by wagon road north of Little Falls, Herkimer county, N. Y., a station on the New York Central Railroad, 79 miles northwest of Albany, and 240 miles from New York,—paying therefor $7,000 in seven annual payments. The Brooklyn felt works were immediately removed to Brockett's Bridge, at that time little more than a "place in the woods," without stores or railway communication, and took with them such of the Brooklyn workmen as would go to this out-of-the-way spot; only ten finally remained in the new

location, the others being unable to endure the privations of this pioneer life in the Herkimer wilds. Dolge's capital at this time had become about $50,000.

The felt factory increased, natives taking the place of the urbanites who fled from the savage existence in the woods; the manufacture of felt shoes and piano sounding-boards was inaugurated; magnificent granite factories were erected, including a finely-equipped machine shop, where many new machines for facilitating the Dolge manufactures were invented and built; Brockett's Bridge became Dolgeville; a railway was constructed, connecting with the New York Central at Little Falls; fine stores, magnificent schools, an elegant Turn Halle, and other accessories of civilized existence sprang into being under the magical wand of the Dolge management; and to-day Dolgeville has a population of nearly 3,000 inhabitants, and is one of the brightest, liveliest, and most picturesquely-located manufacturing villages in the United States, and stands a magnificent monument to the tireless energy and unerring foresight of its founder, Alfred Dolge, who, still under fifty years of age, has achieved such results in the way of successful manufacturing as have rarely fallen to the lot of man. The Dolgeville productions are recognized the world over as the best of their class, having taken first premiums at the world's fair at Vienna in 1873, at Philadelphia in 1876, at Paris in 1879, and at Chicago in 1893.

Alfred Dolge has seen and known and lived the life of master and man in all the varying conditions of the two estates. He has thought deeply on those questions which extended manufacturing operations involve, and he has formulated and put in practice new devices for securing harmony between employees and employer, which seem, at the end of twenty years of entirely successful practice, to fully meet all the requirements of the situation, and which not only avoid strikes and the dissensions which lead to strikes, but provide insurance for the workmen in case of accident or death, and even reach so far into the future as to guarantee the retirement of the workman on full-pay pension when past the age of effective service in the factory.

The story of Dolgeville and Alfred Dolge's "Earnings Distribution" in the three forms of pension, life insurance, and "endowment" has been printed many times, but never has the story been told from the inside by a narrator who was at once fully informed and wholly unbiased; some have written it hastily from incomplete or misunderstood information; some have written it with an absorbed sense of admiration for Alfred Dolge and his success which left little appreciation for anything else; while others have sought in the workings of the Dolge system of labor recompense a witness to the accu-

racy of their own theories and imaginings, which nothing in the facts of the Dolge methods can be held really to support.

The Dolge "System of Earnings Distribution" embraces the three divisions of pension, life insurance, and "endowment," the endowment feature being simply a gift made under certain circumstances to a workman who is, in Mr. Dolge's judgment, deserving of something more than his wages.

In his youth Mr. Dolge was a firm believer in Socialism as taught by Karl Marx; this was an inevitable result of his early surroundings and the wide benevolence of his character; he could see plainly the hardships of the life of the German workman, and that these were not the fault of the industrious and sober toiler, but of the system under which he worked; and the theories of Karl Marx seemed to his youthful imagination and sensibilities to hold a complete solution.

With increase of years and a full knowledge gained by experience, both as workman and employer, Mr. Dolge, as a matter of course, came to fully realize the insurmountable obstacles which prevent the practice of any commercial system independently of individual effort rewarded, in case of success, by individual gains, and to fully understand that capital is merely accumulated labor, and has all the rights and earning powers of the labor which produced it.

Yet Mr. Dolge's quick sympathies retained, despite his broadening knowledge of commercial realities, a deep pity for the life of the ordinary workman, ignorant of the value and meaning of capital, who spends his earnings as he goes, and finds himself a pauper at the end of his years of usefulness. This pity took on a form of pregnant interest when, after the Vienna Exposition of 1873, Mr. Dolge visited many of the continental piano factories and found them all in the same plight, doing a poor business with antiquated methods and machinery and old workmen, long past their best days. To one after another of the proprietors of these decaying factories Mr. Dolge put the same questions, and from each he received the same answers; they did not adopt the new methods and improved machines which were needed to put them in successful competition with the more modern piano factories which were rapidly monopolizing the trade, because it was impossible to introduce novelties successfully without discharging the old workmen, and they had not the heart to put the faithful servants of the past into the street to starve. As Mr. Dolge tells it, "'Here is something for you to think about, Alfred,' I said to myself. And then I began to think what I would do,—how I could arrange things so I could say to a man, when he could earn his pay no longer: 'You get out; I have had you long enough; I want a younger man in your place.' Then I thought of the pension."

The Dolge pension system has now been in operation for twenty years. At first sight it seems that twenty years is not a sufficient time to fairly test a system with an increasing number of possible pensioners, but a brief consideration will show that a yearly tax of one per cent. of wages paid would undoubtedly cover both the life insurance and pension cost. Pensions are paid to workmen entering service between twenty-one and fifty years of age, and begin to be payable only after ten years of continuous service ; at the expiration of the first ten years of continuous service the pension is fifty per cent. of wage, and gradually increases until it reaches one hundred per cent. at the expiration of twenty-five years of continuous service ; this puts the age of the youngest full-pay pensioner at forty-six years, and, should such a pensioner live to the age of seventy-one, he would then have drawn double pay for his twenty-five years of work. But, by the conditions, the pension is to be paid only in case of partial or total disability to work, and, as the ordinary workman may be regarded as efficient in most classes of manufactory employment up to sixty years of age, the management has the option of paying the pension or retaining the eligible pensioner in active service up to the age of sixty, which would reduce to eleven years the period of idle pensionership for the supposed life of seventy-one years, as against forty years of continuous service, and so would add but little more than twenty-five per cent. to the wages account to make the total of wages and pension, and the twenty-five per cent. added no more than represents the increased earnings due to continuous service, certainty of avoidance of troubles with labor, and other vast economic advantages resulting from long-continued harmonious association of master and man.

Thus, within the twenty years ending December 31, 1894, there entered and re-entered the Dolge service 2,046 male employees. Of these, on January 1, 1894, 10 had remained in continuous service for more than 15 years, 29 for from 10 to 13 years, and 68 for from 5 to 9 years, making a total of only 107 workmen out of 2,046, or about 5½ per cent., eligible to endowment (which begins after five consecutive years of service), and, of these 107, only 39 had been in service more than ten years, which gives less than 2 per cent. of the whole number as eligible for pensions, while the actual number of pensioners at the end of 1894 was only three, and the total amount of pensions paid, as per the Dolge statement dated 1894, is only $7,172.56.

The Dolge workmen are paid day rates almost exclusively, though there are about fifty piece-workers in the piano-hammer department. Mr. Dolge declares himself wholly opposed to piece-work and to any cutting of day-rates, and is a firm believer in high protection and high wages.

TABLES OF COMPARATIVE EARNINGS PER YEAR IN DOLLARS.

(Published in 1889.)

		No. 1	No. 2	No. 3	No. 4
	Dolge.	Mass.	England.	France.	Germany.
Hours' work per week	59	60	56	72	76
Wool carders	684	422	360	231	200
Fullers	474	367	276	174	145
Finishers	450	376	312	225	140
Hammer coverers	708	...	...	...	...
Machinists	738	671	324	260	175
Dyers	474	442	264	225	147
Wool sorters	490	461	288	231	160
Laborers	423	429	240	210	145
MECHANICS. AVERAGE YEARLY EARNINGS.					
Plumbers $600					
Carpenters 450					
Shoemakers 555					
Cutters 480					
M'ch. hands 477					
Gluers 519					
Turners 675					
Tool makers 660					
Moulders 562					
Sawyers 525					
Cabinet makers 543					
6,046					
Average.	550	517	320	245	195

1.—Report of Carroll D. Wright, commissioner of labor, 1881.

2.—Report of parliament, 1883.

3.—Report of United States Consul-General Walker.

4.—Report of United States Consul Dubois, 1881.

These tables show that the wages in the Dolgeville factories are 15 per cent. higher than those paid in the Massachusetts factories, 79 per cent. higher than those paid in the English factories, 138 per cent. higher than those paid in the French, and 227 per cent. higher than those paid in the German factories.

The average hour pay is under 20 cents per hour, and the tool-maker's pay is only 21 cents per hour against the 27-30 cents rate paid machinists at Midvale: but I think the Dolge tool-makers should not rank much above the Whitin machinists, whose hour rate is about 16½ to 17 cents. The factory uses no women workers. Living expenses are not much higher at Dolgeville than at Whitinsville or South Manchester, and not nearly so high as at Stamford or Philadelphia, which makes the Dolge hour rates virtually higher than they appear, because of increased purchasing power. No shorter statement of the Dolge system seems possible than that here appended, which is taken from a pamphlet, dated 1896, entitled "The Plan of Earnings Division."

"The name of every male person employed by Alfred Dolge & Son is placed at entry upon a register which shows nativity, date of birth, date of entry, age, department of the business in which he entered, transfer, if any, from one department to another, giving date of such transfer, date of voluntarily quitting employ, with reason therefor if known, or discharge by the firm, with record of the cause therefor.

"On December 31 of each calendar year the employees of that date whose names appear upon this register recorded prior to July 1 of that year, and the names thereon recorded between July 1 and December 31 of the preceding year, are placed upon the record book of the earnings division account, accredited to the department in which they are employed. The record book made up at this date shows the wages of each employee thereon enrolled for the year just closed and the amount to be paid thereon by each department of the business to the earnings division fund, on account of contributions thereto for pension fund, deposit fund, endowment fund, or life insurance expense. The basis of contribution to pension fund is 1 per cent. upon the amount of wages enrolled on record book December 31 of each year, which amounts are charged by each department respectively to its manufacturing expense account for that year.

"The contribution to endowment fund is made by each department in accordance with the manufacturing record therein, for the benefit of entitled employees to their individual credit in the earnings division account, and charged by the several departments to their manufacturing labor account.

"The contribution to 'deposit fund' is made by each department for the benefit of entitled employees under the 'insurance' provision, to their individual credit in the earnings division account for payment at maturity, and charged to its manufacturing expense account for the year. Life insurance policies are purchased (twenty payment life) and maintained during the time the recipient remains in the employ of Alfred Dolge & Son, the premiums being paid by each department and charged to manufacturing expense account. The insurance policies are in possession of, and remain the property of, the recipients after quitting employ of the firm, the holder having choice of a paid-up policy of as many twentieths as are years paid, or of continuing the payments himself to maturity.

"To the amount of each of the several funds is added semi-annually interest at the rate of six per cent. per annum, to the credit of the pension fund at large and the individual recipients under endowment and deposit accounts, in accordance with the terms respecting these funds.

"The benefits accruing to employees are conditioned upon a term

of continuous employment by Alfred Dolge & Son. In case of voluntarily quitting employ, or of having been discharged and re-entering the employ of the firm, the beginning of the term is the last date of re-entry. The twenty-first birthday of minors who enter the employ of the firm shall be deemed the date of entry for such employee.

"All and every one of the provisions under which benefits are conferred are entirely voluntary on the part of Alfred Dolge & Son, and no obligation or liability is created in favor of any employee either at law or equity.

"Every employee on the roll of earnings division who is over twenty-one and not over fifty years of age on the day of entry shall, after a continuous service of ten years, be provided, in case of partial or total inability to work, caused by accident, sickness, or old age, as long as such inability may last, the following proportion of the wages earned during the last year next preceding the accident, sickness or old age the cause of inability.

After 10 years' continuous service, - -	50 per cent.
After 13 years' continuous service, - -	60 per cent.
After 16 years' continuous service, - -	70 per cent.
After 19 years' continuous service, - -	80 per cent.
After 22 years' continuous service, - -	90 per cent.
After 25 years' continuous service, - -	100 per cent.

"At any time previous to the completion of ten years' continuous service, in case of accident while on duty in the service of Alfred Dolge & Son, or of sickness contracted through the performance of such duty, such employee shall be entitled to receive a pension equal to fifty per cent. of the wages earned by him during the year preceding such accident or disability.

"Employees who draw salary or earn wages to the amount of one thousand dollars or more per year, in case of partial or total inability to work, caused by accident, sickness, or old age, as long as such inability may last, are provided for as follows:

After 13 to 16 years of service, - -	$600 per year.
From 16 to 19 years of service, - -	700 per year.
From 19 to 22 years of service, - -	800 per year.
From 22 to 25 years of service, - -	900 per year.

"After twenty-five years of continuous service not exceeding $1,000 per year.

"As the pension is an equivalent for lost wages, the benefit is strictly personal, and not transferable under any circumstances.

"In case of partial loss of wages, where earnings are not cut off entirely, but only reduced, the pension is computed on the difference of wages only, representing the loss actually sustained.

"Employees of Alfred Dolge & Son entering the services thereof at or under the age of twenty-one shall, after five years of continuous service, at the age of twenty-six, receive a first policy of life insurance of $1,000; after ten years of continuous service, at the age of thirty-one, a second policy of $1,000; after fifteen years of continuous service, at the age of thirty-six, a third policy of $1,000.

"Entering the service thereof at any time between twenty-two and twenty-five years of age inclusive, shall, after five years of continuous service, receive a first policy of life insurance of $1,000; after ten years of continuous service, a second policy of $1,000; after fifteen years of continuous service, a third policy of $1,000.

"Entering the service thereof at any time between twenty-six and thirty years of age inclusive, shall, after five years of continuous service, receive a first policy of life insurance for $1,000; after ten years of continuous service, a second policy of $1,000.

"Entering the service thereof at any time between thirty-one and thirty-five years of age inclusive, shall, after five years of continuous service, receive a policy of life insurance for $1,000.

"Every employee entering the service thereof at the age of thirty-six years or over that age shall after completing five years' continuous service, have deposited, invested, or set aside by Alfred Dolge & Son, annually at the expiration of each and every additional year of continuous service thereafter, the sum of $35 for not exceeding twenty consecutive years of additional service. The aggregate of the deposit, including the interest accumulating thereon, if invested on interest, shall not, in any event, however, exceed the amount of $1,000.

"Every employee entitled to policy or policies of life insurance whose application to the life insurance company for such insurance is rejected shall have deposited or set aside annually, at the expiration of each additional year of continuous service of such employee, an amount equal to the annual premium upon the life insurance policy or policies with which he would have been provided except for such rejection. The aggregate of the deposit in lieu of life insurance, including the interest accumulations thereon, if invested on interest, shall not exceed in amount the face value of the policy or policies with which such employee would have been provided.

"In case of the death of an employee, the amount so deposited, invested, or set aside on behalf of such employee, with the accumulations of interest thereon, if invested on interest, shall, within sixty days after proof of death, which proof of death shall be made out upon blanks, in the form and by the persons as required by Alfred Dolge & Son, be paid over to the heirs or representatives of such employee. The interest on all such sums so deposited, invested, or

set aside shall cease from the day on which such employee leaves the employ or is discharged therefrom.

"Every male employee of Alfred Dolge & Son over twenty-one years of age, and who has been in their employ for five consecutive years, shall be entitled to an Endowment Account.

"At the end of each year so much shall be credited to this account as, according to the manufacturing record kept by Alfred Dolge & Son, is demonstrated he has produced more for Alfred Dolge & Son than has been paid to him in the form of wages. If, by neglect or carelessness, he has caused a loss, as appears from the manufacturing record, the same is charged against such employee on this same account. Upon any balance in his favor at the end of every such year of service, he shall be entitled to interest at the rate of six per cent. per annum, interest to be credited at the end of each year, but the interest thereon will cease from the day he leaves the employ or is discharged.

"This endowment money shall be payable to such employee only on his arriving at the age of sixty years, or, upon his death before that time, to his legal heirs or representatives.

"Nothing in any of the provisions for benefit under the earnings division system impairs the right of any employee to quit the employ of Alfred Dolge & Son at any time and for any cause or reason, or the right of Alfred Dolge & Son to discharge any employee at any time and for any cause or reason."

Tables given in the continuation of this pamphlet show clearly that one per cent. of wages paid will more than cover the cost of pension and life insurance, under the rules and limitations adopted at Dolgeville.

The "endowment" is a gift, pure and simple, although it is based on a system of careful departmental book-keeping, but, when, from any cause, profits decrease below a certain figure, the "endowment" is suspended, although the workman is in no way responsible.

At the "Reunion" of January, 1896, Alfred Dolge said:

"At our last Reunion I stated that my system of labor pension and insurance had passed the experimental stage; that a practical test of twenty years had proved the correctness of the theory underlying the system,—namely, that the employer not only could well afford to pay one per cent. of the wage fund toward labor pension and insurance, just as he pays annually from five to ten per cent. for wear and tear of his machinery, but that it is an excellent investment from a purely business point of view, and that this system could be nationalized so that each wage-earner could derive the benefit of the same without being hampered in his movements.

"England gave the world the factory system, and with it the fac-

tory slave. America should give the world the emancipation of the toiler from the wage system as founded by the Manchester school; in other words, the highest forms of corporations founded upon co-operation of brain and brawn in a mutually satisfactory relationship. This can be accomplished by the introduction of a labor pension and insurance system, and by no other means."

The Dolge holdings to day comprise a large number of patents on very valuable inventions; the extensive Dolgeville factories, employing, when full, about 1,200 hands; 45,000 acres of valuable timber lands in Herkimer, Fulton, and Hamilton counties; and almost unlimited water power. The firm looks forward confidently to a maximum of not less than 5,000 employees, when all of its great natural resources shall have been fully developed.

Despite Alfred Dolge's earnest repudiation of paternalism, it is difficult to see where his treatment of labor differs in results from that of Whitinsville or South Manchester. Pure air, pure water, excellent drainage, beautiful surroundings, fine schools, and cheap living, although there are no tenements owned by the firm in Dolgeville, are potent factors in the success of the three places alike. The life insurance and the pensions of Dolgeville cost no more, perhaps, per workman employed, than the unrecorded benefactions of the Whitin and Cheney management. It is, of course, a far more independent affair for the workman, if he enters service under a general system of established laws than if he depends solely on the final good will of his employer, but it matters little in final averaging of labor cost, whether the superannuated workman be pensioned, or kept on so long as he can crawl to the scene of his daily efforts for a lifetime of years. At Midvale the death of a workman brings his heirs $600 in the form of a 50-cent assessment on each employee, to which the management adds $250 in case of five years' service of the decedent; and the workman who has been inside the gates but a single hour is insured for $600, while at Dolgeville five years of continuous service and the age of 26 years are conditions preceding life insurance benefits, in no case exceeding $1,000 on one risk.

The Dolgeville "endowment" is as purely "paternal" as any gift of father to meritorious son could be, and is a variable, liable to sink to zero for successive years.

Yet, all in all, the Dolge system is a true system, inasmuch as it is formulated, and has proved successful in practice for twenty-two years, and, although each year does not end the liabilities, which are moral obligations on the management, it puts the relation between employer and employed more nearly on a footing of dollars and cents than do the Whitin and Cheney methods.

FOUNDATION CONSTRUCTION FOR TALL BUILDINGS.

By Charles Sooysmith.

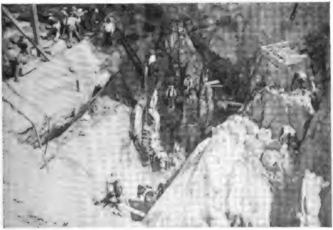
IF the extreme height of the modern office-buildings awakens our wonder and comment, we may also note with amazement the distance from which many of them spring from beneath the surface.

Indeed, great as was the stride upward which was taken when the first of them was built in New York city, the proportional increase of depth of some of their foundations is even greater. For instance, one of the buildings,—that of the Washington Life Insurance Company, soon to be commenced at the corner of Broadway and Liberty street —will rest upon rock seventy-five feet below the street surface.

The great increase in the height of buildings came very quickly with the visible possibilities of high-speed elevators and steel-frame construction, but the corresponding and necessary change in the character of, and the method of obtaining, suitable foundations developed much more slowly. Stories were added to the height because they would increase revenue, but old foundation methods, with few exceptions, were adhered to until absolute insecurity threatened.

Chicago is credited with being the birthplace of the modern office-building, and it was there that the use of steel beams to spread the bearing at the base (the first material departure from old methods) first came into use. In the old style of construction, which, for a building of only a few stories, called for walls thick at the ground level, it was easy and natural to get the area of base necessary to reduce the pressure on the soil to a safe amount per square foot by simply widening out the base of the wall by off-sets, making them of brick, stone, or concrete. In Chicago the clay on which the city is built is comparatively hard and firm above the level of the water in the lake, but below this level it becomes much softer, its power of resistance being insufficient to prevent it from yielding continuously under loads of three or four tons per square foot or even less. To keep the load within one and one-half to two tons per square foot,—which has been considered safe practice there,—the architects commenced, ten or fifteen years ago, to found their walls and columns upon bases of concrete, strengthened by layers, at first of railroad rails and later of "I" beams, employing these in order to spread the base without penetrating the softer clay below the hard top, thus, as it is now called, floating the foundations on grillages of steel beams.

Just as the architect with proper artistic feeling studies his building from both far and near, its roof line and the general sky-line about it, so there are many points of view from which the engineer must study the problem of proper foundations for a given building. He should first know the character of the site,—that is, the nature of the material beneath the lot to be occupied by the building. This can be readily ascertained by borings made by one of the inexpensive methods. In some important cases of very heavy loading it may be wise to determine, by one or more borings with diamond drills, whether supposed bed-rock be not boulders or a thin stratum underlaid by another of dangerously soft character; but this is seldom necessary. The natural water-level should be ascertained, not by a single observation, but by one or more pits in which the water is allowed to stand, that its level may be measured during as long a period as practicable, and care should be taken that there be no temporary local circumstances, such as a leaky pipe or drain, or inflow of rain, to make the measured level abnormally high or low. Often excavations in the vicinity, or pumping from a driven well, may, for the time being, materially lower the water-level. The great importance of knowing what can be relied upon as the true and permanent water-level is obvious when piles or steel beams are to be used in the foundations, for piles generally begin to decay in a few years, unless submerged, and it is a difficult thing, to say the least, to so protect steel beams as to secure them against



A DEEP FOUNDATION AT THE CATHEDRAL OF ST. JOHN THE DIVINE.
Looking down into rock excavation 55 ft. below the surface. Cleaning rock preparatory to laying concrete.

FOUNDATION WORK FOR THE CATHEDRAL OF ST. JOHN THE DIVINE.
A deep rock excavation, with rotten over-lying rock removed.

corrosion when submerged. The piles should never be used, unless they are to be continuously and certainly below water-level, and steel beams should be placed only where they will or may be submerged when there is an important engineering or economical reason for it. In any case the most approved methods should be employed to protect them from rust.

If, because of the excessive depth of an unyielding stratum, or for economical reasons, the building must rest upon a soft material, such as mud or fine wet sand, the possibility that this may find lateral escape from the load above it must be considered; for the material settlement of a building, where not caused by compression of the underlying earth, is to be explained in the majority of cases by either a general disturbance of the mobile material of the neighborhood, or a movement in response to lateral relief by deep excavation carelessly done near by. It is undoubtedly true that in such cities as Chicago and New York the jars from heavy trucks passing on the paving blocks are so many blows, each adding its infinitesimal increment to the readjustment of particles of earth, whenever made space in the neighborhood renders readjustment possible. The potency of these wheel-blows can hardly be questioned, when one notices the vibrations they often cause in the highest and heaviest buildings. When we think of the glacial movement of great masses of solid ice, it seems reasonable to look for a somewhat analogous, though, of course, slower, general

movement of soft material when unequally loaded and subject to changing conditions of drainage, loading, and shock. There are parts of some cities where the land for some distance back from river-banks has a movement riverwards measurable even in a short period.

The foregoing remarks about the unrest of the soft strata on which many of our cities are built are made in order to draw attention to general conditions that frequently exist and are wholly overlooked. They may be ignored in light and inexpensive structures. For economical reasons they cannot be guarded against in the majority of the larger buildings. But in the extremely heavy and costly ones they should be taken into account, lest a foundation otherwise ample should be unsuitable because of influences affecting the earth on which it rests. In fact, the chief problem to solve in designing foundations for most of our high structures in lower New York and in many other places is not to get a sufficient resistance to settlement under the conditions existing, but to so build that extraneous influences from other constructions or operations shall not render the support insecure.

With the data in hand as to water-level, nature of strata beneath the site, surrounding conditions, and the loads to be carried, the architect or engineer can proceed to the design of his foundations. If there is a firm stratum at slight depth, it is necessary only to excavate to this and provide a base for the columns either by masonry or gril-

PART OF THE FOUNDATION, CATHEDRAL OF ST. JOHN THE DIVINE.

This concrete base, about 20 ft. thick, will carry one of the four great tower-piers. The surface as shown is at the level of the crypt floor.

lage of steel-beams affording sufficient area to reduce the load per square foot to a safe amount. This, of course, will depend upon the nature of the material beneath. On the clay of Chicago it is unwise to have the load exceed one and a half or at most two tons, and even then a certain amount of settlement is inevitable, due to compression or squeezing out of the water in the clay beneath; the architect there thinks that a great deal is accomplished when the ratio of load of each part of his building to the corresponding support is such that all parts of the structure settle uniformly, and the uniformity of the clay in nature and depth are such that this has not been difficult. Apart from the objectionable cracks that would come with unequal settlement, the arrangement of beams, braces, and partitions in a steel frame building might easily result in a dangerous concentration of strain on some members, if others were relieved by unequal settlement.

In New York the steel grillages are sometimes laid directly on rock, in order to avoid occupying valuable cellar-space with large pedestals of masonry.

Where the water-level is such that they will remain submerged, and when it is practicable to drive them properly, piles make a most excellent and cheap foundation for buildings that will not load them, either separately or collectively, beyond the amounts usual in good practice. But the error should not be made—as it unfortunately has been in some conspicuous instances—of assuming that the total bearing-capacity of a large number of piles driven closely together is equal to the sum of their individual carrying-powers. The small piles often used and driven closely together amount in many cases to little more than replacing so much earth with an equal volume of piles, and these very often broomed up on the bottom.

When the underlying strata are of soft or comparatively soft material, such as prevails in Chicago, or of fine silt and sand, like that which exists for from forty to more than eighty feet beneath the surface in lower New York, the architect is practically limited to one of three plans for his foundations: either to float them on a steel grillage, or to put them on piles, or to sink them, by means of cylinders or caissons, to bed-rock or hard-pan.

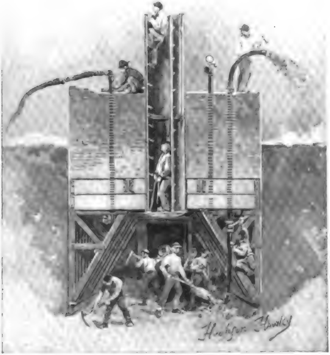
In the case of the Manhattan Life Building in New York,—the first of the very high office-buildings where the caisson method was resorted to,—the architects, Messrs. Kimball & Thompson, found that enough piles could not be driven in the lot to properly support the loads, and that to float the building on grillages was out of the question, because of the danger that the soft material beneath would escape laterally under its great load. To make open excavations to the bed rock, some fifty-four feet beneath the street surface, was not safe, if

A CAISSON DELIVERED COMPLETE, READY FOR SINKING.

The one shown, used in the Standard Oil Building, weighed about 38,000 lbs.

possible, because of the danger of undermining adjacent buildings. To obviate all this, it was decided to sink steel caissons by the pneumatic process, as is done in obtaining foundations for most of the great bridges. Thus was inaugurated, four years ago, the caisson method now coming into extensive use for buildings.

A pneumatic caisson is simply a diving-bell, on top of which the pier or foundation-structure is built. It consists usually of a rectangular or round box made of boiler-plate steel. It is seven or eight feet high and without bottom, and of length and breadth in accordance with the size of foundation-pier required. After being set in position



CROSS-SECTION OF A CAISSON.

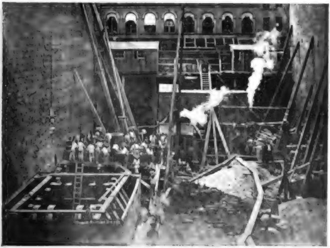
Showing working chamber, air-lock, and method of "blowing" material.

on the lot, the construction of the brick or concrete pier upon its roof is commenced. A passage-way through this latter and the roof of the caisson is provided by means of an iron tube, usually three feet in diameter. This is closed by means of an immense double valve, or air-lock. Men enter the caisson beneath the pier and commence undermining it, the material being hoisted out through the tube. When the water-level is reached and the excavators are troubled by the gradual

entrance of the water into the working-chamber of the caisson, air is blown in through a pipe. This air is supplied by powerful steam air-pumps, and its pressure holds the water down to a level with the bottom or cutting-edge of the caisson. The men and the excavated material can pass through the tube without relieving the air-pressure, because the air-lock has two doors, only one being opened at a time, and the pressure between them being regulated slowly, to avoid injury to the workman by the sudden transition to or from the compressed air.

The operation of undermining the caisson and building upon it is continued, until the cutting-edge reaches bed-rock. This latter is then cleaned, and, if sloping, is stepped off; then the entire chamber is filled solidly with concrete. The pier, then, consists, first, of the concrete base or filling of the caisson surrounded by the walls of the working-chamber; next, above this, and forming part of the permanent work, the metal roof, a fraction of an inch thick, of the caisson; and, above this, the pier proper, of brick or concrete.

The speed of building the foundations in this way is much increased by the fact that, while the excavation is being made, the pier itself is being built, so that it is actually finished within a few hours after the



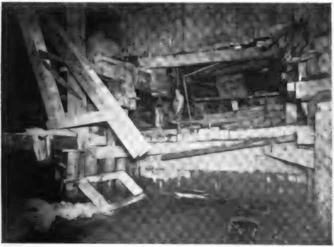
CAISSON BEFORE ROOF-PLATES ARE ATTACHED, SHOWING POSITION OF BRACKETS.

Brick-layers at work on another caisson, building brick-work preparatory to sinking. Manhattan Life Building.

excavation is completed. The weight of the masonry and metal, and additional temporary load when needed, force the caisson down against the upward pressure of the air against its roof, and, when properly conducted, the sinking results simply in pressing an immense plug into a passage-way cut for it through the earth to the bed-rock, thus permitting no flow of material into the excavation to endanger the support of the adjacent buildings.

The cellar-floors of the new buildings are almost invariably placed at a lower level than the foundations of the older buildings adjoining, and for this reason, if for no other, it has been the custom to shore the adjoining building. The favorite method of doing this now is to cut notches in the wall, and in these to sink pipes built up of sections screwed on as sunk, taking the weight of the building on these pipes. In the case of the great building about to be put up facing Trinity Church at Broadway and Rector street, the adjoining building is being thus supported before the buildings to be torn down are removed. Some very valuable time will be saved in this way. The work is done from the basement of the building to be removed, without disturbance to anyone, by cutting openings through the walls of the building to be removed and opposite to each of the notches in which pipes are being sunk under the adjoining building. In some cases it may prove eco-

SHORING SCHERMERHORN BUILDING DURING CONSTRUCTION OF AMERICAN SURETY BUILDING.



SHOWING METHOD OF SHORING AND SHEATHING FOR UNDERPINNING. STANDARD OIL BUILDING.

nomical and entirely feasible to build the foundations for a new building before removing the old buildings. When tenants of the old building cannot be induced to give up their leases on reasonable terms before the end of the regular term,—in New York the first of May,—such a procedure might enable a new building to be completed by the beginning of the next rental year.

The time required now to build the foundations for a large building by the caisson method is from two to three months, but this time will doubtless be lessened with increased experience.

Cylinders, within which to build foundation-piers for buildings, have been sunk without the use of compressed air, by simply loading them and easing up the friction and resistance by jets of water. This method has very great limitations, and, because of the liability of endangering near-by buildings by disturbance of the material, and of the uncertainty of getting the cylinders to the proper position and depth, so that they can be cleaned out and the foundation well built, the method seems likely to be used only when the conditions are particularly adapted to it.

It is probable that in some cases, rather than sink isolated caissons, or rows of them, it would be better to sink one or more caissons to cover the entire lot, not filling these with masonry, but using them

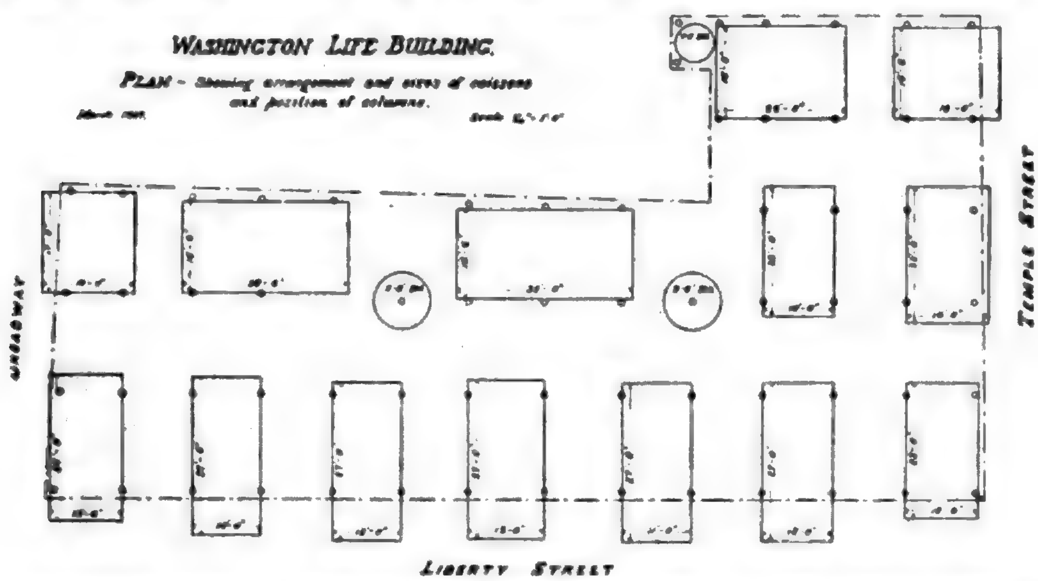
merely as shells or coffer-dams, by which the exterior walls of the building and its columns could be carried downward to the rock and the entire space utilized for stories below ground. The walls of the caissons may become the walls of the building, in part or wholly, and its roof may be one of the floors. With ample fresh air brought by flues from the roof of the building; with white tile finish and electric light; with absence of the usual basement masses of masonry, since the columns themselves would be carried down; and with the elevators running down to them,—I believe that for safety-vaults, restaurants, barber shops, etc., the rental of such stories would, on the most valuable sites, pay a fair return on the cost of the entire foundations. In this craze for high building, when we contemplate the possibilities of having ere long to go the country or the roof to find out if the sun shines, is it not time to make this plea for additional depth rather than increased height.

VIEW UNDERNEATH WORKING PLATFORM. STANDARD OIL BUILDING.

It is the great misfortune of the sub-structure engineer that his work is not in evidence. He may build well, but he must bury his work, and, unless the space be utilized as just suggested, the money he spends brings no apparent revenue. Hence, doubtless, the hesitation of many owners to go to the expense of supporting their buildings on a rigid foundation; and yet the cost of this, as compared with that of the cheapest possible foundation, generally would not exceed it by 5

per cent., and seldom, if ever, by 10 per cent., of the cost of the building. To offset this there would be in most cases reduced cost of repairs from cracking of plaster, settlements, etc., a longer life of the structure, and in New York city the consequently higher rental value. In an advertisement of the highest office-building in the city it was lately set forth in large type that the building stands on solid bed-rock, whereas in reality it is floated on fine sand, and has been provided with an ingenious arrangement by which any of its columns can be lifted and shimmed up by means of hydraulic jacks inserted in the pedestals beneath the columns.

The investor who builds a great building to-day must bear in mind that we cannot expect these twenty-story buildings to be out-grown in



DRAWING SHOWING SIZES OF CAISSONS AND POSITION OF COLUMNS FOR PROPOSED WASHINGTON LIFE BUILDING.

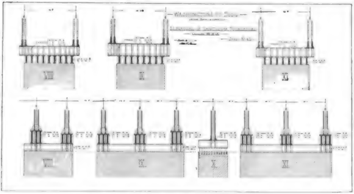
C. L. W. Eidlitz, Architect.

a few years, as the four- or five-story buildings have been. They should be built to last; the steel and wood, when hidden, should be protected from decay; and the metal and masonry should not be overstrained. He should also remember what the value of the structure may be ten, twenty, or thirty years hence, and what its reputation is likely to be in the light of that day's knowledge of high buildings. A structure just finished may have defects which seem of little commercial consequence now, because serious consequences from them are twenty, thirty, or forty years off. Ten or twenty years hence they may be visibly impending. As yet there have been no disasters or conspicuous failures of any of the finished high buildings; doubtless in the main they have been too well built for us to anticipate any; and, happily for static conditions, the factors of safety have very large margins.

Yet it is more than possible that some one or few, through faulty design or careless or dishonest construction, may fail; and, whether the particular imperfection causing the failure be quick-sand under the building, rust or over-strain of some of its members, or something else, the value of every structure having the same possibility will be materially affected. If a single one of the prominent new buildings on a floating foundation were to threaten to give way, the selling value of every large structure in the city on a similar foundation would decrease to an extent far greater than the sum it would have cost originally to support it on a trustworthy stratum.

This plea for the building of the best foundations is made to owners, who are the ones who need to be reminded of their interest in them. The architect will, as a rule, be only too glad to have them, but he is generally under injunctions of economy, and, unless encouraged by a proper attitude on the part of the owner, will often hesitate to urge the outlay necessary to provide foundations in keeping with the weight and cost of his building.

As the statutes now stand in New York city, the builder of a new edifice has to protect from settlement the adjoining buildings, when the latter have foundations more than ten feet below the street level. This has been fair enough in the past, but during the last few years many very heavy buildings have been erected on shallow foundations with fine sand, in some places practically quick-sand, beneath them. This has been put under so great pressure, and under such a tendency to seek lateral escape, that the owner of an adjoining lot, when he



ELEVATION OF PART OF A CAISSON FOUNDATION.

Showing arrangement of cantilevers and position of steel columns on the foundation piers. Proposed Washington Life Building, New York.

wishes to build, must either limit himself to a shallow foundation, which may mean a permanent improvement inadequate to the site, or meet the risk and heavy cost of protecting, by underpinning or otherwise, his neighbor's building. The law should be amended; either the excessive over-loading of the soil at slight depths should be prohibited, or the adjoining owners should be relieved from liability for settlements caused in carrying out with reasonable care the excavations necessary in improving their property.

The evolution of the new type of business buildings has been startlingly rapid. Probably the further advances to be made will not be in the direction of greater height, but in that of improved structural character and true economy of design. That greater attention to the matter of foundations is now a marked feature is shown by the fact that, of the six high office-buildings to be built the coming season in lower Broadway, four are to have caisson foundations sunk to the rock by the pneumatic process, and foundations of the same kind are to be used in the new custom house in Chicago.

(The illustrations of the work on the foundations of the Cathedral of St. John the Divine are used by the courtesy of the architects, Messrs. Heins & La Farge.)

AMERICAN AND BRITISH BLAST-FURNACE PRACTICE.

By J. Stephen Jeans.

I. THE GROWTH OF THE SYSTEM OF INTENSIFIED PRODUCTION.

IN the checkered and eventful history of the iron industry, there is no record or movement of greater economic importance than that which, during the last thirty years, has in most cases trebled, and in many others has more than quadrupled, the output of blast-furnace plants in nearly all the leading metallurgical countries of the world. This movement, which is still in progress, and likely to lead to even more remarkable results than those hitherto recorded, naturally is occupying the minds of pig-iron makers in all countries alike. Indeed, it may truthfully be stated that no subject connected with that industry is at present more in the thoughts of blast-furnace owners than that of how far they should proceed in the direction of rivaling the great yields that have been achieved by a few of the leading firms in the United States, and by a smaller number in Great Britain and Germany.

Before proceeding to consider the conditions under which the record yields of the United States and European countries have been achieved, it is desirable that we should have before us a few historical facts relative to the actual results hitherto arrived at in some of the European countries that are entitled to be regarded as competitors and rivals of each other and of the United States.

Dealing first with Great Britain as one of the oldest and most notable of iron-making countries in the past, it is hardly worth while to recall the conditions that prevailed a century ago, or, indeed, of any period prior to about thirty-five years ago. The blast furnaces of an earlier date were generally of so small dimensions, used so limited a pressure of blast, and were otherwise so at variance with the conditions that have given us the enormous yields of the present day, that they could hardly be regarded as in any sense the same sort of apparatus. Until the Cleveland district came to the front, about 1850, the ironworks of Great Britain, mostly located in Scotland, Staffordshire, and South Wales, had made but little progress since the commencement of the century, when the total make of pig iron in the kingdom was estimated at less than 150,000 tons. The furnaces as a rule, were open-topped, had a cubical capacity of less than 5,000 tons, and were considered to have done well, if they produced 3,000 to 4,000 tons

per annum. The introduction of the hot-blast by Neilson gave a stimulus to the pig-iron industry between 1840 and 1850, more especially in Scotland, where it originated; but it appears to have operated rather in the direction of reducing the previously large consumption of fuel than in that of bringing about better blast-furnace practice generally. Furnaces continued to be of small dimensions, the height seldom exceeding 40 feet, with a bosh ranging from 12 to 15 feet, and a cubical capacity of 3,000 to 5,000 feet.

While the older iron-making districts of Great Britain were producing, between 1840 and 1850, from two to three million tons of pig iron per annum in this sleepy and unprogressive fashion, the Cleveland district in North Yorkshire came to the front as an active competitor of the older and more conservative regions. For a time even the pioneers of the Cleveland iron industry had to move cautiously, and it is doubtful whether they were animated with any sort of assurance that they could do better than their competitors. At any rate, it was not until 1861 that any furnaces were built exceeding 8,000 feet in cubical capacity or 17 feet bosh. In that year Messrs. W. Whitwell & Co., of Thornaby, constructed three furnaces with a capacity of 12,178 cubic feet, a height of sixty feet, and a bosh of 20 feet. This plant at once gave much better results than any previously recorded, and, with the aid of the Whitwell hot-blast fire-brick stoves, which were soon afterward introduced by the late Mr. Thomas Whitwell and his brother, Mr. William Whitwell, these yields were considerably improved. The next most important departure in the same district was the erection in 1864, by the firm of Stevenson, Jaques & Co., of three furnaces with a cubical capacity of 17,000 feet, a height of 70 feet, and a bosh of 22 feet. Again the results of increased dimensions were successful, and hence, in 1867, the Norton Iron Company, near Stockton-on-Tees, was induced to build a plant of two furnaces, each with a cubical capacity of 26,000 cubic feet, a height of 95 feet, and a bosh of 25 feet. The progress here was rapid enough even for American practice, for within seven years the cubical capacity of the furnaces had been more than trebled, the height had been increased from about 60 to 95 feet, and the bosh had been increased by 8 feet. All this, of course, was more or less experimental, seeing that neither the Cleveland district or any other had at that time the experience required to give absolute proof that the experimenters were moving in the right direction; and naturally it was felt that there was a limit beyond which neither height or cubical capacity could be increased with advantage. It was generally believed that that limit had been reached, if not exceeded, in the case of the new furnaces built by the Norton Iron Company in 1867. Nevertheless, the boldness and enterprise of the ironmasters

of Cleveland did not stop even there. Three years later, the firm of Cochrane & Co. constructed two furnaces, each with a bosh of 30 feet, and a cubical capacity of 41,149 feet, while the Rosedale & Ferryhill Company erected two furnaces of 100 feet in height, and 50,000 feet capacity, being more than ten times the capacity of any furnaces built in Great Britain up to 1850.

It is from this date that the great makes of the blast furnaces both of the Cleveland and of other districts may be said to originate. Between 1866 and 1896, while most countries and most other districts were still lying on their oars and taking things easy, the Cleveland district, by the increased productive resources of each new plant added,—and in those days plants were run up quickly—was enabled to forge ahead of all others. In 1866 the average annual make per furnace in that district was 9,751 tons. In 1896 it had increased to 16,813 tons, being an increase of more than seventy per cent. over the make of ten years before, and in later years the make has risen to more than 30,000 tons per furnace, without any further increase of size. Indeed, it has been found, of recent years, that the exceptional dimensions attempted by Cochrane & Co., the Ferryhill Iron Company, and one or two other firms did not yield any corresponding advantage, and for a time there was a tendency to rather diminish than increase the size of the new blast furnaces built, both in Cleveland and in other districts. So far as the United Kingdom is concerned, the experience gained in Cleveland was applied in the still newer district commonly called the West Coast (which embraces North-West Lancashire and West Cumberland), where the height of the furnaces seldom exceeds 70 feet, and the capacity is usually under 30,000 cubic feet. British ironmasters have since realized what was discovered and acted upon at a much earlier date in the United States,—namely, that it is not mere size that enables large yields to be produced, but that a suitable size must go hand in hand with greater blast pressures and other conditions that constitute what is known in Europe as American practice.

It was on the West Coast that the furnaces in Great Britain first attained an average of more than 25,000 tons per furnace per annum; but this result was mainly owing to the richer ores made use of. Cumberland ore, at that time, was wholly used on the West Coast; such ore contains, on an average, more than fifty per cent. of metallic iron, as against about thirty in the ores of Cleveland. Even, however, with the rich ores of Cumberland, the West Coast furnaces in 1866 were not making more than 11,000 to 14,000 tons per furnace per annum,—a yield which ten years later had improved to between 16,000 and 18,500 tons. In no other district in the United King-

dom did the average annual yield per furnace in those years exceed 12,000 tons, and in most of the older districts—West and South Yorkshire, South Staffordshire, and Shropshire—the annual yield did not exceed 8,000 tons, even so recently as twenty years ago. At that time a feature of the British iron industry was the manufacture in South Wales of anthracite pig iron, which has since then been entirely discontinued. The make of such iron was never large, but in 1866 it was as much as 34,516 tons, being an annual average of only 3,138 tons per furnace in blast. About 1890 the last anthracite furnace in the United Kingdom was discontinued, although some iron makers are sanguine enough that, under more modern conditions, the industry might be resumed with advantage. It may here be added that there are still 119 anthracite blast furnaces in the United States, of which 40 were in blast on June 30, 1896, as compared with 56 at the end of December, 1895. If we take the average of December 31, 1895, and June 30, 1896, as representing the number of furnaces in blast during the intervening period,* it appears that the anthracite furnaces were making during that time at the rate of 28,500 tons per furnace per annum, while the bituminous coal (coke) furnaces in operation during the same period were making at the rate of about 60,000 tons per furnace. In the United States, therefore, as in Great Britain, the anthracite furnaces are far behind the bituminous standard, although, of course, American practice is far ahead of British in both categories.

The considerably larger quantity of material that has always had to be passed through the blast furnaces of Great Britain has, of course, been a sufficient explanation of the lower yields of the blast furnaces of that country, compared with those of the United States, and in all probability always will be so. Of the total consumption of iron ores in British blast furnaces in 1895, amounting to about 17,500,000 tons, about 7,000,000 tons were hematites of British origin or imported. The average richness of this latter ore does not exceed fifty per cent., and the average of the imported hematite is rather under that figure. On the other hand, the British blast furnaces have to consume a very considerable body of ores that average no more than thirty per cent. Such are the ores of Cleveland, Northamptonshire, Lincolnshire, Leicestershire, and North Staffordshire, amounting to an aggregate, in 1895, of about 9,000,000 tons, and equal to the production of about 3,000,000 tons of pig iron. The latter give conditions more nearly identical with those of Alabama than with those of any other district in the United States, and should, therefore, be compared with the re-

*In the United States there do not appear to be any official statistics of the *average* number of furnaces in blast during a period.

sults of blast-furnace working in that State, if compared at all. Even so, however, American practice leaves that of Great Britain far behind. The average output of the furnaces in blast in Alabama during the first half of 1896 was 21,150 tons, which is equal to an annual output of 42,300 tons per furnace. In the Cleveland district of Yorkshire, however, the average annual output per furnace in blast in 1895 was only 32,400 tons, although in this case the local ores are invariably calcined so as to produce about forty per cent. of iron in the furnace, while nearly one-half of the total quantity of iron now made in the Cleveland district is hematite, Spanish ores containing, on an average, almost fifty per cent. of iron. When we compare the outputs of furnaces using hematite ores exclusively, the results are much more favorable to American practice, as regards yields. The bituminous coal furnaces of Pennsylvania yielded in the first half of 1896 at a rate of about 60,000 tons a year per furnace, assuming the average number of furnaces in blast in the half year to be the mean of those recorded as blowing at each end of the period. In North-west Lancashire and Cumberland, which use almost exclusively bessemer ores, containing, on an average, more than fifty per cent. of iron, the average output per furnace in blast during the same half year indicated a rate of 32,000 tons per furnace per annum. Neither basis of comparison, therefore, shows the United Kingdom in a favorable aspect.

Before passing from this point, it is only proper to remark that some of the blast-furnace authorities of Great Britain have been inclined to dispute whether the large yields characteristic of American practice are, on the whole, an advantage. The argument is that hard driving tends to shorten the life of the furnace, and that the chief aim to be kept in view by the ironmaster is to get as large a yield as possible out of a furnace during its "campaign," whether that campaign be long or short. In other words, it is argued that, if a furnace producing, say, 60,000 tons a year, can give a total output of only, say, 200,000 tons before being relined, it is a more costly business than a furnace which gives, say, 220,000 tons in its life, although producing only 30,000 tons a year. The American system has been described in England as "a short life and a merry one." The English system, *ex hypothesi*, is to be regarded as a long life and a dull one. I do not here lay down any actual rules or facts; I merely state the drift of the argument. As a matter of fact, it is well known that record "campaigns" have been got under both systems, and, so far as I know, the facts do not justify the inference that a furnace producing a smaller annual yield will show a larger life's work than a furnace producing a greater annual yield, despite the relevancy, in some similar cases, of the well-worn aphorism, *festina lente!* There are not available, within

my knowledge, a sufficient number of examples to justify generalization on the point. But the difference from this point of view, whatever it may be, is not usually regarded as so important as the difference of joint cost of installation and labor costs. Regarding the former, I may point out that, in the United Kingdom, furnaces of the modern type known in the United States are few and far between. Only two concerns in Great Britain have hitherto attempted to build furnaces on American lines,—the Dowlais Iron Company in South Wales, and the Palmer's Iron and Shipbuilding Company in the north of England. In both cases the cost incurred is understood to have been far above the average. Indeed, in most of the older districts of Great Britain furnaces rarely cost more than £20,000, although in some of the more modern plants of the Cleveland district the cost exceeded £30,000. I have before me particulars of a plant recently erected at the Glengarnock Ironworks in Ayrshire (Scotland), where two furnaces were erected by Mr. Edgar Richards (eldest son of Mr. E. Windsor Richards, the respected past-president of the Iron and Steel Institute) for a trifle more than £14,000—this figure covering everything except the blast engines, which were already on the ground. I believe it will be interesting to give illustrations of these furnaces, which are in most respects the most modern hitherto adopted in Scotland.

The question of the cost of large blast-furnace yields has received a new impulse from the enterprising action recently taken by the Carnegie Company, in building at Duquesne four furnaces, costing, it is estimated, £150,000 each. These Duquesne furnaces have several unique features, as might be expected in a plant of such proportions. A friend who has recently examined the plant—which was not sufficiently advanced for examination when I was in the United States last year—informs me that each is 100 feet high, and has a 20-foot bosh, and a 12-foot well, with ten tuyeres, equipped with four Cowper stoves per furnace, while the distance between the furnaces is not less than 560 feet. These furnaces were designed to give an annual output of 182,500 tons each, and even this enormous rate of output has occasionally been exceeded. With this output a blast furnace costing £150,000 would yield 1.2 tons per pound of first cost per annum. In England a furnace costing £30,000 will seldom yield more than one ton of annual product per pound of capital expenditure, although, of course, in some cases they show better results. Up to this point, then, the advantage appears to be on the side of the higher-priced plant. But there are other considerations that enter into a calculation. The most important and obvious of these is the total capital expenditure incurred relatively to the total yield of iron obtained. If

the furnace which cost £150,000 is to give, as an alternate yield, during its complete life, five times the quantity of iron that would be got from a furnace costing only £30,000, the two would appear to be quits. If the more costly furnace gives less, then, measured merely by the standard of ultimate product, it would not be so economical. In the case of the Duquesne furnaces, however, as is generally known, a very large part of the high cost is incurred in providing appliances and means for economizing labor, and to such a point has this object been carried that both fillers and chargers are entirely dispensed with. Outlay thus incurred is, of course, well expended, although, at first blush, it looks so serious that none but the boldest and most wealthy would be likely to face it. In England, as in all pig-iron making countries, the results of the great experiment made by the Carnegie Company at Duquesne will be watched with interest, and it is quite on the cards that in the future it must be largely followed, if pig-iron makers are to be up-to-date.

So far as labor costs are concerned, I do not hesitate to declare that it is impossible to fix the proportions in which the expenditure for labor enters into the final cost of pig iron in any country or district, although, of course, it is otherwise with individual works. I make this statement unreservedly, despite the attempts made by many authorities on both sides of the Atlantic to compare costs in the United Kingdom and the United States. I do not know of any two works in Great Britain—and I am acquainted with the economic conditions of many—where the labor costs are the same. But I do know that, if—to take one or two instances—the labor costs of the Derwent Iron Works and the Moss Bay Works in West Cumberland, or of the Palmer Works on the Tyne and the Tudhol Works on the Wear, are compared, there will be material differences. I propose, however, to enter upon this important subject of labor costs in another article, and would, therefore, now add only that, while in the United Kingdom these costs range from 1*s.* 11*d.* per ton to 4*s.*, and in the United States from $1 to $2.50, it is practically impossible to arrive at a decision that shall be entirely free from attack from one side or another.

EPOCH-MAKING EVENTS IN ELECTRICITY.

By G. H. Stockbridge.

I. VOLTA—ELECTRICITY OF TENSION SUCCEEDED BY THAT OF MOTION.

WHETHER those who discovered the great facts of science or those who explained the facts and enunciated their pervading meaning in set laws have contributed more to the advancement of the arts that send men to softer beds, with easier muscles and wiser heads, would be an engrossing subject of study and speculation. One understands immediately the value of knowing the how and the wherefore. Without annulling the zest of inquiry, it steadies, fosters, regulates it by supplying the investigator with rational expectations of reward and awakening a just personal pride in success. On the other hand, there are great scientific discoveries or experiments which fire the brain like old wine or a noble poem. Such a discovery, associated with the name of Professor Röntgen, is fresh in the minds of us all. It set the whole scientific world to passing rays of light through substances we have been wont to call opaque. And not in play, either; for it is within the expectation of everyone that most beneficent inventions will date from this surprising discovery.

Such an event is to science like the discovery of the new world to stagnating Europe; and for a similar reason. For this new domain, too, is likely to be the shore of a new continent, or, at the very least, an outlying island, or the far and unknown side of the familiar Indies. In either case, it is a promise of work or adventure for those who wish them, homes for contented families, and fruitful fields for genius as well as for honest industry and capacity. These quickening presentiments of discovery, before science has begun to set her bounds and cordons, are among the most wonderful manifestations of human intuition; yet they generally prove to have been rational, and wise men build on them. If the first movement of the needle to the lodestone stimulates to wilder dreaming and larger prophecy than the soap-bubble, there is sure to be some sound and subtle reason for it. The Arabian Nights tales are, after all, truer than Mr. Howells's realism. In the broadest interpretation of science, they have a larger place and a completer justification. But the instinctive expectation of which we have been speaking regards not the principle of action in the thing discovered, but depends on the mere sentiment of science. It marks the poetic, the Arabian Nights period. The strictly intelligent pursuit of the subject begins when some philosopher has formulated the laws.

Lest this repeated allusion to the stories of Scheherazade should

seem somewhat too fantastical, let me say that the stories were, in all probability, written at a period when Arabia had newly experienced the awakening coming from just such a series of discoveries through contact with more advanced civilizations. The author simply abandons himself to the description of the physical possibilities suggested by his new knowledge. But it is fair to add that the unequalled interest which men have had in the marvellous accomplishments of those beings who, in the Thousand and One Nights, stand for power or active energy under human control is due to the fact that the world has recognized itself in them. Not in gratitude to one who relieves an irksome and tedious routine by picturing a pleasant unreality has the universal homage been paid to the author of these wonderful tales (we should be poor fools, indeed, to be cheated so palpably), but in loyalty to a spirit that had faith in human power, deserving, and destiny,—a spirit awakened, be it remembered, by the sudden revelation of things theretofore beyond its ken.

It is with a few of these imagination-stirring revelations or discoveries that the present brief series of papers has to deal. To all but the special student they may appear self-born, without progenitors, yet they have their own laws. One is sure that the major discoveries of science were not accidental. They were made by men on the lookout for them.

To be more specific, it is the purpose of this series of papers to call attention to three of the epoch-making discoveries in electricity and magnetism, and particularly to the literary records through which the knowledge of them was first published to the world. Starting with the idea of going back to the sources, as the Germans say, one may thus exhibit the science in its growing state; may make its significant facts and its real problems more apparent, and their true solution more clear, by showing how the facts appeared to their discoverers, and what the actual solutions of the problems were, as worked out by those who first succeeded. In general, then, in this series, there will be coupled with the disclosure of the original discovery some briefer or longer statement of the work of those who developed its laws. Further, it seems best to maintain, so far as possible, a certain unity, and this consideration leads to the determination to start with Volta's experiments with the "artificial electric organ" in the form of a "column" or a "crown of cups," and follow with Oersted's discovery of electro-magnetism and Arago's experiments with his rotating disk.

The first published disclosure of Alessandro Volta's marvellous discovery of current electricity was a letter, originally written in French, addressed to the Right Honorable Sir Joseph Banks, president of the

Royal Society, read before the Society at its meeting of June 26, 1800, and printed in the Philosophical Transactions for that year. Some ten years earlier Volta, who was professor of physics at Pavia, had travelled through France, Germany, Holland, and England, and become personally acquainted with their principal men of science. It was natural enough that he should communicate the first news of his great discovery to the British Royal Society, through its president. This disclosure marks the passing of science from the knowledge of animal electricity, and of electricity in a state of equilibrium or tension, to the knowledge of those phenomena of electricity which are a consequence of its motion, when the equilibrium has been destroyed. It was the starting-point of about all that we admire in the modern electrical arts. How immensely the scope of electrical adventure was broadened by Volta's work could be foreseen only dimly at the time. Volta himself simply said that such experiments "opened a wide field for speculation, particularly for the anatomist, the physiologist, and the practitioner." To one who arrived at his success through the study of animal electricity, this modest expectation was the natural one. But the mode of his progress is not to be forgotten. Volta was impelled to his own investigations by Galvani's earlier work. But, while Galvani appears to have regarded the nerves and muscles of the frog's-leg as the source of the electrical phenomena, and to have ended there, Volta finally discarded the animal tissues altogether, and after having examined the mutual action of metals and salts, he produced a genuine "electromotive apparatus," or electric generator, the forerunner of the modern electric battery.

The first form of his apparatus was a "column," which he describes as follows:—"I provide several dozens of little round plates or disks of copper, brass, or, rather, silver, an inch in diameter more or less (coins, for example), and an equal number of plates of tin, or, what is much better, of zinc, almost of the same shape and size. I say *almost*, because precision is not necessary, and, in general, the size, as well as the shape, of the metallic pieces is arbitrary. The only precaution necessary is that they be capable of being arranged conveniently one above the other in the form of a column. I prepare also a pretty large number of circular pieces of pasteboard, skin, or some other spongy matter capable of absorbing and retaining considerable water or moisture, with which they must be well saturated in order to insure the success of the experiments. These circular pieces or sections of pasteboard, which I shall call moistened disks, I make a little smaller than the metallic disks or plates, so that, when interposed between them, as I shall hereafter describe, they may not project beyond them.

"Having all these pieces at hand and in good condition,—that is to say, the metallic disks very clean and dry, and the non-metallic ones well saturated with common water, or—what is much better—with salt water, and wiped a little so that the moisture may not drop off, I have nothing to do but to arrange them at my convenience,—and this is a very simple and easy matter.

"To be explicit, I place horizontally on a table or other support one of the metallic plates,—for example, one of silver,—and over the first I fit a second of zinc; on the second I place one of the moistened disks, then another plate of silver, followed by another of zinc,—this succeeded by another moistened disk. I continue in this manner, coupling a plate of silver with one of zinc, and always in the same order,—that is, the silver always below and the zinc above, or *vice versa*, according as I have begun, and interposing a moistened disk between each of these couples, I continue to form, out of several of these stories, a column as high as it can be made without danger of falling over."

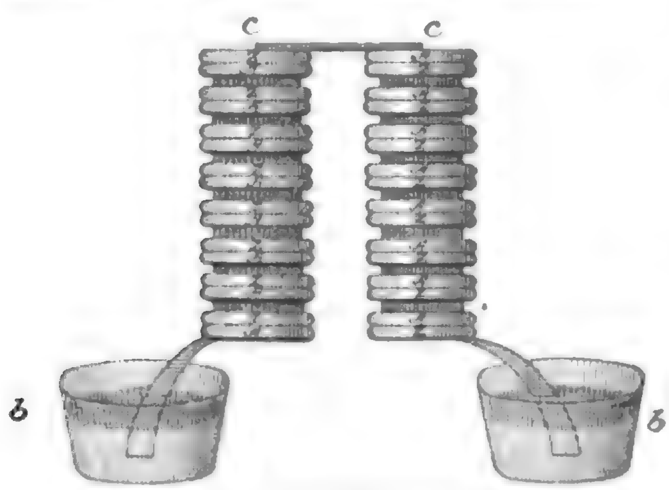


FIG. 1. VOLTA'S COLUMNS.

In the illustrations Figure 1 shows two such columns coupled together for greater effect, and constituting, either singly or together, what is commonly known as the voltaic pile. Volta's "crown of cups," typical somewhat more nearly of the modern battery, is shown in Figure 2, and described as follows in Volta's letter to Sir Joseph Banks.

"Take a row of several cups or basins of any material except the metals,—say, wood, shell, earth, or preferably glass (small drinking glasses or tumblers are the most suitable),—half full of pure water or, preferably, salt water or lye. Connect them all by forming them into

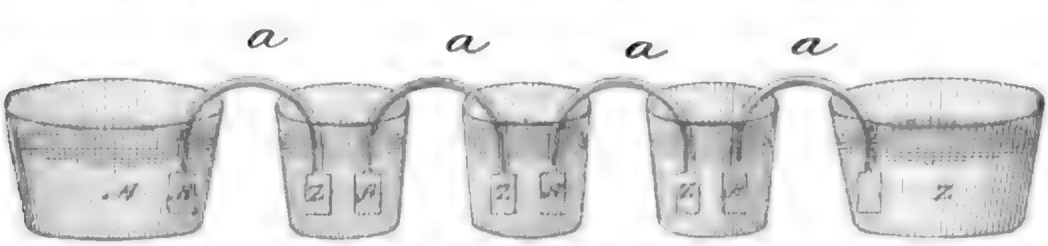


FIG. 2. VOLTA'S CROWN OF CUPS.

a sort of chain by means of so many metallic arches, one arm of which, Aa (or, at least, the extremity, A, which is immersed in one of the tumblers), is of copper or brass, or, preferably, of copper plated with silver, while the other arm, Z, which is immersed in the next tumbler, is of tin or, rather, of zinc. I will remark, in passing, that lye and other alkaline liquors are to be preferred when one of the immersed metals is tin; salt water, when it is zinc. The two metals of which each arch is composed are soldered together at some point above the part which is immersed in the liquid, and which part ought to touch the liquid with a pretty large surface of contact. It is sufficient for this purpose, if this part be a plate an inch square or a little less. The rest of the arch may be as much narrower as you choose, or even a simple metallic wire. It may also consist of a third metal, different from those immersed in the liquid of the tumblers; for the action on the electric fluid which results from all the contacts of several metals immediately succeeding each other,—the force with which this fluid is ultimately impelled is absolutely the same, or nearly so, as that which it would have received from the contact of the first metal with the last without any intermediate metals, as I have ascertained by direct experiments of which I shall have occasion to speak elsewhere.

"Now, a series of thirty, forty, or sixty of these tumblers joined in this way, and arranged either in a straight line or a curve, or bent in any manner, forms all there is of this new apparatus, which essentially and in substance is the same as the column described above. For the essential thing, which consists in the immediate communication of the different metals forming each couple, and the intermediate communication of one couple with another,—namely, by the interposition of a humid conductor,—is characteristic of one of these devices no less than of the other."

Such was the simple—not to say crude—apparatus with which Volta demonstrated that artificial electricity could be made to act continuously,—as a current,—and not merely explosively and intermittently. This device was the first generator of electricity in motion; it was the real beginning of the science of electro-dynamics. Volta himself gives a remarkably just account of the characteristics of his new invention, though the fundamental explanation of the action eludes him, and leads him to a construction of his column not only crude, but essentially false. He attributes the effects primarily to the mere contact of metals or other conductors of different kinds, and he does not seem to comprehend the true action of the moistened disks; yet he is in the main impressed by the real, and not the fictitious, wonders of his apparatus. Over the contact and the chemical theories of the battery—the galvanic battery, as it came to be called—a dispute of many years has been

waged, in which greater men than Volta have been involved. But the one who made the first voltaic cell had no doubt, it seems, that the generation was brought about by mere contact. He tells his correspondent that he takes pleasure in communicating to him—and through him to the Royal Society—some striking results which he has obtained in the pursuit of his experiments on electricity excited by the mere mutual contact of different kinds of metals, and also on electricity excited by the contact of other different conductors, whether liquid or containing some moisture. "The chief of these results," he writes, "which comprehends nearly all the rest, is the construction of an apparatus which, in its effects,—that is to say, in the shocks it is capable of causing in the arms, etc.,—resembles the Leyden phial, or, rather, a weakly-charged electric battery which acts continuously, or whose charge renews itself after each explosion. In a word, it is like a battery having an inexhaustible charge, a perpetual action or impulsion on the electric fluid. Nevertheless, it differs essentially from such a battery, by virtue of this characteristic continuous action, and because, instead of consisting, like ordinary electric phials and batteries, of one or more insulating plates or thin layers of those bodies which alone are thought to be *electric*, armored with conductors or bodies called *non-electric*, this new apparatus is formed solely of several of the latter bodies, selected from among the better conductors, and thus as remote as possible, according to what has always been believed, from the electric nature. Indeed, the apparatus of which I speak, and which will, no doubt, astonish you, is nothing but an assemblage of a number of good conductors of different kinds, arranged in a certain manner."

The "battery" of which Volta here speaks is, of course, a group of Leyden jars coupled together. That his "electro-motive appararatus"—for so Volta in one passage names it by a happy inspiration —is inferior to such batteries, when highly charged, in respect to the force and the noise of the explosions, in respect to the spark, and in respect to the distance at which the discharge may be effected, Volta freely admits. "It equals," he says, "only the effects of a very weakly-charged battery, though having immense capacity. But in other respects," he adds, "it infinitely surpasses the virtue and power of these same batteries, as it has no need, like them, of being charged in advance by electricity from another source, and as it is capable of giving a shock every time it is properly touched, no matter how often."

In this connection Volta enlarges upon the likeness of the "artificial electric organ" which he has invented to the "natural electric organ" of the torpedo or electric eel. By the former name, indeed, he prefers that his instrument should be called. For is it not, like the

natural electric organ, composed entirely of conducting bodies? Moreover, is it not active of itself, without any previous charge, without the aid of electricity excited by any of the means hitherto known? Does it not act incessantly and without intermission? And, finally, is it not capable of giving at any moment stronger or weaker shocks, according to circumstances,—shocks which are renewed by each new touch, and which, being thus frequently repeated or continued for a certain period, produce the same torpor in the limbs as is caused by the torpedo?

As to the general principles of action of the new source of electrical energy, such principles are, after all, deduced from experiment, and Volta's experiments taught some things in the rough which it became the province of the later science to develop with exactitude. For example, Volta could not help observing that the force of the current was increased by the multiplication of the "stories" of his column or the cups of his crown. And he also notes the mutually-neutralizing effect of groups of cells having the elements arranged in opposition to each other; so that Davy, when he obtained unheard-of results by the use of his battery of 400 five-inch plates, and his other battery of 40 plates 12 inches across, only made use of the greater effects which Volta, too, knew to reside in the larger battery. If we owe the discovery of potassium and sodium and magnesium and strontium to Davy, we can at least see how Volta set the first guide post.

The most remarkable feature of the new contrivance from a purely characteristic scientific point of view was the production of electricity through the medium of good electrical conductors. The substances originally called electric were amber, glass, silk, and the like. By rubbing them one could get an electric spark. Volta exhibits great surprise at finding that he can obtain electricity from good conductors or so-called non-electric bodies.

Is it true, then, that this small column and this crown of cups, which, by their inventor's own account, were weaker in their effects than a highly-charged battery of Leyden jars,—is it true that this apparatus affected the imagination of science, and aroused hopes of some new and strange development in the world of industry and the arts? Undoubtedly. For, while the dynamic effects were no greater than what had long been known, yet some of the effects were theretofore completely unknown as the product of an artificial apparatus. The molten, flowing element had more of promise and adaptability in it than the congealed electricity of the frictional machine and the Leyden jar. It is not too much to say that the world of science was never more thoroughly awakened than it was by the publication of Volta's letter. The main thing therein that was disclosed by Volta's experi-

ment was that electricity could be set and maintained in motion by an artificial appliance. It appears that Volta looked upon his generator as inexhaustible, subject to no waste, so far as he suggests. It remained for later investigators, like Ampère and Ohm, to fix mathematically the laws of flow of the mysterious voltaic current. That his powers were not adequate to this particular part of the work was frankly and characteristically acknowledged by Volta, who waited for others to do what he could not. And it was not till the year of Volta's death (1827) that Ohm, in his "Galvanic Circuit Treated Mathematically," finally stated the fundamental principle of electric flow in his famous law. But meanwhile improvements in the voltaic battery had been going on without ceasing, and they continued to do so, the chief names of honor being Becquerel, Davy, Smee, Wollaston, Daniell, Grove, Bunsen, and Léclanché.

In connection with the later enunciation of the laws of current flow and distribution, the following passage from Volta's letter is of more than ordinary interest. It follows the description of the crown of cups already quoted.

"It might occasion surprise that in this circuit the electric current, having a free passage through a continuous mass of water in the basin, should quit this good conductor to throw itself and pursue its course through the body of the person who holds his hands immersed in this same water, thus taking a longer course. But the surprise will cease, if one reflects that living and warm animal substances and, above all, their humors are, in general, better conductors than water. Since the body of the person whose hands are immersed in the water offers an easier passage to the electric torrent, the latter must prefer it, though it is a little longer. In a word, the electric fluid, when it has to traverse imperfect conductors in quantity, and particularly moist conductors, likes to spread in a larger stream, or to broaden into several, or even to make detours, as it thus finds less resistance than in following a single course, though shorter."

If Volta had not arrived at the conception that the current from his electric source divided between different conducting paths in the inverse ratio of their resistances, he was very close to it. Such a conception presupposes an understanding of Ohm's fundamental law, and yet it required twenty-seven years to evolve the clarified mathematical statement of it in the equation, $C = E/R$. Yet that, again, was a masterpiece of scientific deduction from which no fair-minded student of history would wish in any way to detract. Let Ohm enjoy the glory of having been one of the few to discover and to enunciate a true natural law; only let us not overlook the fact that Volta not merely gave us an epoch-making discovery, but hinted also at the

same permeating law whose later authoritative promulgation by Ohm has powerfully influenced the subsequent development of the theory and applications of current electricity.

As has been said, Ohm's chief work was published in 1827. As early as 1825, however, and later in 1826, Volta might have read the preliminary announcement of Ohm's main conclusions in the German scientific journals.

It would be instructive to analyze Ohm's treatment of the principles of electrical distribution, but, owing to the involved and far-leading character of his style, citation is next to impossible. I think science has about come to the conclusion that what it owes to Ohm is adequately summarized in the equation above cited, known as Ohm's law. Of course, other laws equally true and authoritative are deducible from that one, or follow from the same course of reasoning, and such laws are stated in Ohm's thesis. But the basis of Ohm's contribution to electrical science is, after all, the half dozen characters of a mathematical equation. For the rest, it is enough to state here that Ohm arrived at his conclusions through the analogy of heat conduction. It has been said of Ohm that he would never have done his work but for the antecedent investigations of Fourier on the subject of heat. But whereas, owing to the nature of the subjects of inquiry, Fourier's theory was carried only to the point of probability, Ohm's deductions reached the point of absolute proof, so that they have been fortified by every later investigation without exception. As we have seen, Volta himself was not without an incipient conception of the truth of the matter. Others, with the same phenomena before them, likewise hovered around the true notion, or talked loosely of the functions of the electric current, each with his own terminology. Antiquarians even declare that Cavendish, in 1781, made an equivalent mathematical statement of the law, preceded by a general discussion, in 1775, of the mode of electrical distribution between conductors of different resistances. It was a part of Ohm's service that he insisted upon separating and naming the different functions, and proceeding by the methods of science. That his term electroscopic force and others of his suggestion have passed into disuse is insignificant. They served the greater end of enforcing definition, no matter if the specific thing defined was afterwards thought to be better described by a different word or phrase. Having brought scientific men to book by making them say what they meant by "current" and "intensity" and "quantity" and so on, he then gave them the law which, before that, was impossible of statement.

MISTAKES AND IMPROVEMENTS IN RAILROAD CONSTRUCTION.

By George H. Paine.

II. PRESENT ACCEPTED STANDARDS IN PERMANENT WAY.

IN the introductory article on this subject, appearing in these pages a month ago, some account was given of the causes which have contributed to our present tendencies and best practice. The subject was attacked in a general and retrospective manner, without any attempt at drawing definite conclusions.

Here, however, the track and other matters will be treated in detail, and an effort will be made to show what is regarded as good track and in what direction the indicated improvements will probably take place.

In the construction of the embankments, which constitute the foundation, very little advance seems to be possible, since they are of the simplest form. To be sure, earthwork is so obstinate that, no matter how beautifully it may be patted and smoothed, if it be not sufficiently sloped at the time it is made, it will soon, with the never-failing assistance of frost and rain, assume its natural shape, covering the rails through the cuts and leaving the ends of the ties unsupported at the fills. Nevertheless it has continued to be the practice to draw up specifications for railroad work according to the sections shown in Figs. 1A and 1C although it has been clearly recognized that the earth will not retain that form for more than a few months.

Two years ago Mr. D. J Whittemore (*Trans. A. S. C. E.*, September, 1894) asked the American Society of Civil Engineers why such a method should prevail, and suggested that the banks and slopes be originally made to take the form which it is known that they will eventually assume, and offered the sections shown in Figs. 1B and 1D as a substitute. It is not a cause for wonder that substantially the only answer to his question was the Yankee one: "Why not?"

As a subordinate matter, Mr. Whittemore proposed that the slopes be sodded, and the ditches paved and sub-drained as soon as possible after construction, leaving time, of course, for the embankments to settle before covering them. This also seems well, and, although it would involve an expense not to be lightly assumed by a new or an unprosperous road, there is little doubt that there would be an ultimate saving in nearly every case.

Even a slight acquaintance with railroad engineering is enough to

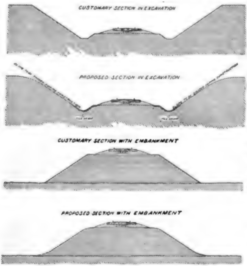


FIG. I. PRESENT AND PROPOSED SECTIONS FOR CUT AND FILL.

convince one that, from a maintenance standpoint, good drainage is the most important result to be secured. Its ramifications are wonderful, and the different conditions which are affected by good or bad drainage make it appear as the one thing which must be remembered, though all else be forgotten.

There are three problems to confront in draining a railway: first, how to dispose of the water which flows under the track in the form of streams; second, how to protect the embankments and slopes against the attacks of surface water; third, how to carry off the water suspended in the soil under the slopes in cuts and under the track itself.

It is evident that the first problem is to be solved only by bridging; it resolves itself immediately into a question of length. After the length of the bridge has been determined, its character is the next consideration, and this is usually decided upon a basis of first cost, expense of maintenance, and general suitability. In the first quarter-century of railroad building but two materials were generally available for bridges,—wood and stone,—although before this period many attempts at iron-bridge building had been made. There is not opportunity in this article to recount the different forms of metal bridges which have been tried; it is sufficient to say that mild steel is the almost universal material in present use. Timber bridges still linger in the form of Howe trusses and trestles in the newer and less settled portions of the country, but renewals are being made in steel, more and more as time goes on, as the cost of timber increases, and that of steel decreases.

Nothing will ever surpass the stone arch in stability or the appear-

ance of rugged strength; as it was the original permanent form of bridge, so it will remain, to engineers and laymen alike, the perfect embodiment of beauty and utility. But the stone arch has many limitations from an economic standpoint. Its first cost is immense as compared with that of metal bridges, and is not adaptable to very long spans (the Cabin John bridge at Washington, 220 feet long, is the greatest in the world) or to situations where it is difficult or impossible to erect "false work,"—that is, the staging on which the arch is formed and supported. The steel arch, however, is not open to these objections. Very long openings have been and will be spanned by it; witness the beautiful creation called the Washington Arch over the Harlem river in New York city, which has a span of 510 feet, and the one which is to supplant the Suspension bridge at Niagara Falls, with a span of 840 feet. It is a matter for regret that no attention seems to have been paid, in the design of this last bridge, to those elements of grace which make a sight of the Washington bridge an unalloyed pleasure.

One of the reasons which probably operated, until within a short time, to maintain the stone arch in the high regard of railroad engineers was the ease with which the track might be placed on it, since it is evident that the only thing to do is to carry the ballast and ties across in exactly the same way as track is laid on an ordinary embankment. As it happens, this is the best thing to do also, but it was impossible, or practically so, on the old wooden bridges, and it was not until the idea of the buckle-plate floor, Fig. 2, was conceived that this method of track-laying began to be followed on girder and truss bridges, where it has since been applied to many spans, some of them of considerable length. Sometimes cross-ties and ballast are used in the spaces marked A; at other times, as in the recently-completed Harlem railroad elevation, the rail is laid directly on the buckle-plates and fastened to them by bolts and clips. The reasons which incline one to think that the solid floor will continue to grow in favor are not far to seek: first, it is believed to distribute the weight of the moving load over a greater area than is possible with the usual floor-beam and stringer construction; second, it provides a safer path for a derailed car.

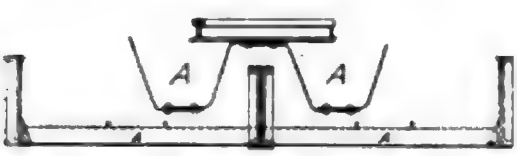


FIG. 2. BUCKLE-PLATE FLOOR.

Reverting again to the question of drainage, the statement is recalled that the second problem to be solved is how to best protect the slopes from the attacks of surface water. This has already been touched upon in the reference to Figs. 1B and 1D, and it is now necessary to say only, that turf is both the most convenient material and the best

that has ever been found for the purpose, while, in addition, its esthetic features must be recognized,—a consideration which, unhappily, is too seldom regarded in this country.

One of the greatest helps to the railroad engineer is the tile drain; it is not possible to exaggerate its usefulness, for wherever it is needed nothing in its place can be more than a makeshift. For the sub-drainage of wet slopes,—to carry off the water which sinks through the ballast and remains suspended under the track, where it will freeze and, as the saying is, "heave" the track in winter,—the tile drain is invaluable, and will be used increasingly as its advantages become better known. To go on month after month, year after year, shoveling slime from the track and ditches in a wet cut, when a less costly means of obviating it exists, seems rather ridiculous, if viewed in the light of pure reason; but it has been the common practice, and it is that, among other things, which the proper and free use of the tile drain will prevent.

Where good stone can be secured at a moderate cost,—say, one dollar per cubic yard,—it is in almost every particular the best material for ballasting the main track of a busy railroad. Perhaps the only reason, under such circumstances, for using gravel instead of stone would be the possibility of securing exceptionally fine gravel at a very small price. But exceptionally fine gravel is a rare thing,—so rare that, as a rule, the first statement may be taken as an established truth and no longer requiring a demonstration. In this place, however, it may be well to state a few of the reasons for the belief.

First: even passably good stone ballast provides better drainage than the best gravel; since this is the most important object to be secured by ballast, the force of the reason is evident. Second: by simply picking stone ballast out from between the ties and handling it with a fork or throwing it against a screen it may be cleaned and made as good as new; there is no generally feasible plan for cleaning gravel ballast. Third: greater rigidity of track follows the use of stone than is possible with gravel, and, since the whole effort is now to increase the immovability of the track, both vertically and horizontally, this is an important consideration. A last reason, and a good one from the passenger department's standpoint, is the avoidance of dust by the use of stone ballast.

At almost any time within the past ten years, it would not have been regarded as either heretical or startling if the statement had been made that the metal cross-tie had come to stay, and that the use of wood must decline; but it would not have been true, since the use of metal for this purpose has not apparently increased much, if any, although its advantages are well known. Some of the causes

for this failure of steel to make its way in a place where it is entirely appropriate (apparently much more so than wood) are very simple. The cost is four or five times that of a timber cross-tie, and there is a wide-spread belief that the greater elasticity of track supported by wood is desirable. The last reason was discussed in the previous article, and need not be further treated here.

The average life of an oak cross-tie is about eight years,—seldom more than ten,—and its destruction is due to various causes. Of these the principal one is ordinary decay, hastened by the alternate wetting and drying to which the tie is exposed; next in importance is the destruction of the fibres directly under the rail, which are exposed to the blows delivered by the train; lastly, in certain localities many ties are destroyed through frequent re-spiking, and the consequent multiplication of holes, which fill with water and add to the tendency to decay, as, for that matter, the second cause does also in a great degree. Much progress is now being made in the treatment of ties with different preserving compounds intended to destroy at their inception the fungi which are the direct cause of decay. It is not yet possible to say which of these preservatives are best, or whether any of them have reached that stage of perfection which will ensure a long continuance of the efficiency that undoubtedly exists during the first few years of their presence in a piece of wood. The difficulty seems to have been in the finding of a compound which shall at the same time be effective, low in price, and not soluble in water; the immense advance which modern chemistry is making encourages the expectation that the problem will be solved. If it is, the question of metal ties will be transported into a dim future, since, instead of having to renew all the ties in the main track of a railroad at least once in every eight years, the period may be extended to twenty years, or even more.

Any discussion of this subject would be incomplete without a description of the one device of all others which, taken in connection with some wood-preserving process, will enable our railroads to postpone indefinitely the use of metal ties. This article is the Servis tie-plate, a thing so simple in form and idea that the wonders which it works are incomprehensible unless the conditions are understood. It is a plate of steel whose long edges (A B, Fig. 3) are turned down in the shape of ribs and sharpened so as to permit them to enter the tie parallel with, and without destroying, the grain of the wood; incidentally other ribs may be placed between the outside ones, but they are not essential. These ribs act as girders, and prevent the plate from buckling or curling up at the ends under the downward pressure of the rail,—a fault which must exist in all plates not provided with them, unless these other plates are made so thick as to

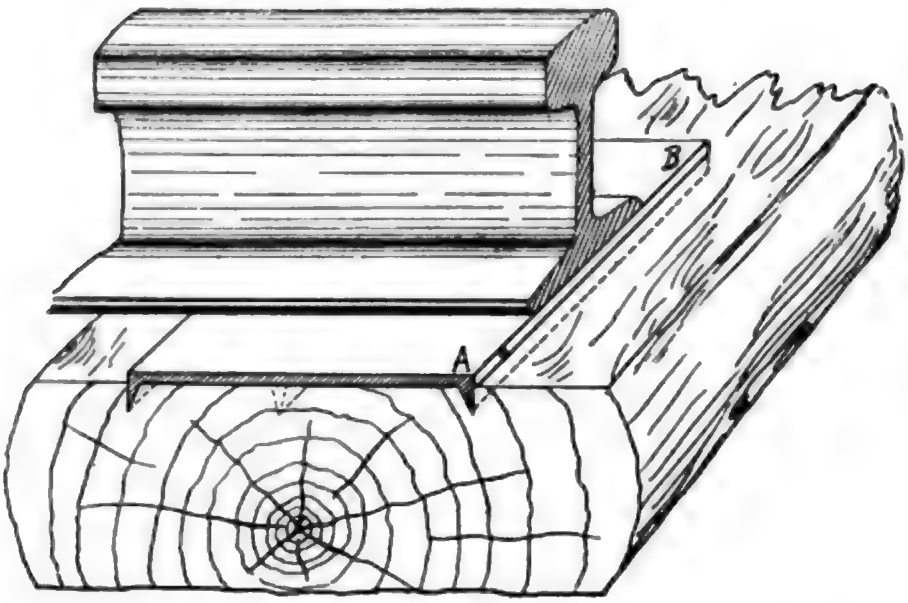


FIG. 3. THE TIE PLATE.

destroy their usefulness through a different cause. The ribs also act as a lateral support to the rail by assisting the spikes to perform their duty. Until this means of protecting the tie from the pounding and crushing by the rail had been discovered, only the harder woods, such as white oak, were available; but there are other kinds of timber that resist decay just as well as oak (some of them better), which are too soft, unless protected, and these are already coming into use under the fostering care of the tie-plate.

Thus it is seen that the two chief enemies of the wooden tie, decay and abrasion, are likely to be greatly weakened, while the supply of new material is immensely increased through the opportunity of using a greater variety.

When the double-headed rail, which is still the standard on most British lines, disappeared from this country, there went with it the chair which must always be used to fasten it to its support, and its place was taken by a device substantially the same as that which we are using to-day—the rail spike. If there is a spot in our track which is patently weaker than others, it is the spike, but there is nevertheless a good reason why it has been allowed to remain. Of all the horrors which stare a maintenance-of-way engineer in the face, "shimming" is the worst. It means, first of all, that the track is insufficiently drained, sometimes from lack of proper ballast, sometimes from inadequate ditches; but, whatever the cause, bad drainage in our latitudes always means heaving track and shims for four months in the year. Of course this is due to what is by courtesy called "economy," and for real ingenuity is on a parallel with the act of the man who cut off his dog's tail, made a soup from it, and gave the

dog the bone; whatever it may be called, the lack of drainage is the direct cause of shims, and shims apparently are the reason for the spike in its present and historic form. On heaving track the rail fastenings must be removed once in the winter and once in the spring, in order that the rail may be either raised or lowered to meet the changing elevations caused by the frost swollen earth, and the most convenient fastening for the purpose is the rail-spike.

The objection to the common spike in its present form, as already demonstrated, is not confined to the direct harm which it does; its inefficiency is proved by the fact that it has to be re-driven. The tie plate gives it a much-needed bracing laterally, but nothing apparently can be done which will add much to its vertical resistance. Notching it, curving it, changing its angle with reference to the rail, and many other alterations have been tried, but none of them have increased its holding-power to the degree which must be secured in order to bring this detail of the track up to the standard of modern requirements. How this will be finally accomplished is of comparatively little moment here, but it is appropriate to say that it will probably be in the direction of a lag screw, possibly somewhat after the fashion suggested by Col. Katte, chief engineer of the New York Central & Hudson River Railroad, wherein a limited lateral movement for the adjustment of the rail is provided by means of clips (Fig. 4); these can be slightly moved with reference to their distance from the base of the rail by tightening or loosening the lag-screws as it may be desired to shift the rail in one direction or the other.

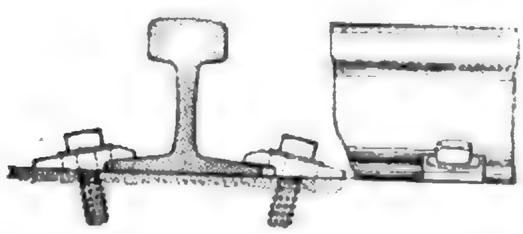


FIG. 4. COL. KATTE'S LAG SCREW.

Probably the most uncertain tendencies in the permanent way of a railroad are connected with the question of rail joints. There are plenty of radical defects in the angle bar, whether it be the four-hole or six-hole bar, and there are few engineers who are not convinced that some particular one of the many patented devices is better; but, on the other hand, few of these engineers seem to agree as to which of the improvements is best, so that to indicate a general preference for any individual form is impossible. If there is a tendency, it seems to lie in the direction of a bridge joint, either as a girder (Fig. 5), or as a truss (Fig. 6), and in nearly every case toward an arrangement which carries the weight of the train directly to the base of the rail (instead of largely under the head, as with the angle bar) and utilizes two ties as a support—in other words, as abutments—for the bridge joint. The

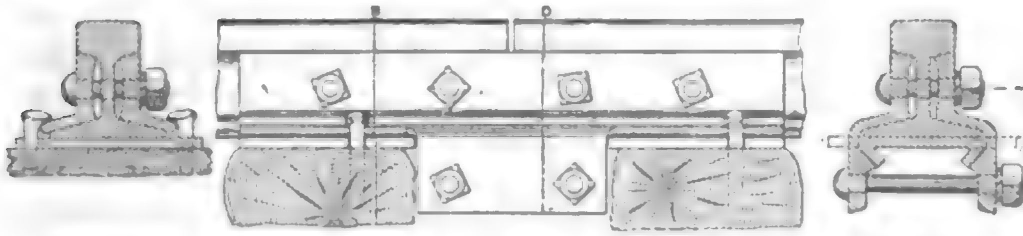


FIG. 5. BRIDGE JOINT, GIRDER FORM.

two forms illustrated, it will be seen, provide for the lateral continuity of the rail by means of fish plates (some are in the form of angle plates, some are plain straps), and this is typical of all modern patterns.

Recent experiments seem to show that the expansive force of steel, and the inclination to buckle, if confined at the ends, during an increasing temperature, have been greatly overrated; and, if this be so, another method is likely to step in and settle the question permanently by entirely eliminating the joints. Until within a short time it has been the universal practice, and is still almost so, to lay the rails with slight spaces between their adjoining ends to permit automatic local adjustments under varying temperatures, but on some electric lines the plan of "butting" the ends has been tried with extremely good results. Mr. Torrey, chief engineer of the Michigan Central Railroad, has also tried some interesting experiments with long stretches of rigidly-connected rails, which show, as before stated, that the behavior of rails under considerable changes from heat to cold and *vice versa* is different from what might have been expected. Previous to Mr. Torrey's investigations, the idea had been patented and tried, but in an unscientific manner, while he kept bi-daily records of the temperature of the atmosphere, of the rails, and of their movements.

Three distinct methods have been practised for accomplishing the union between the ends of rails. The first, which consists in riveting the angle-bars together and to the rails, must be little better than a temporary arrangement, and scarcely superior to bolting them very tightly, since the connection can never be so intimate and permanent as where the metal is actually continuous. The second method is to cast the

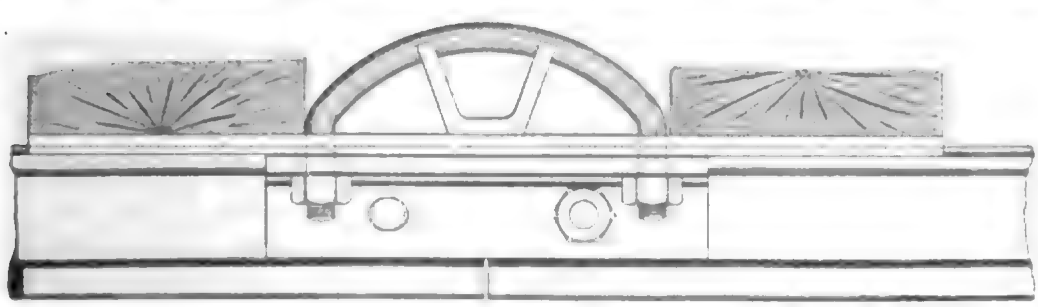


FIG. 6. BRIDGE-JOINT, TRUSS FORM.

ends of the rails together by means of movable molds, which are placed around the joint and poured from a portable furnace; the results of this practice are said to be good, and it is stated that the temperature of the casting metal is high enough to soften the skin of the rail, and in that way form a nearly, if not quite, perfect union. The third plan bears with it an assurance of reliability which is not shared by the others; here, by means of an electric current, the ends of the rails are welded together, so as to form a continuous and nearly homogeneous line of metal.

But, whichever plan shall prevail, whether it be in the way of new joint appliances, riveting, casting, or welding the rails together, there is little doubt that the future individual rails will be longer than those of the present day; rails forty-five feet and sixty feet long are already common in the track, while almost all of the important mills roll in lengths of ninety feet, cutting them up into lengths of thirty feet before shipment.

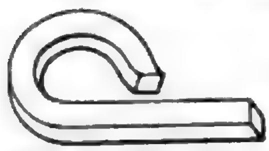


FIG. 7. NUT LOCK.

One of the track details which has always aroused great interest is the matter of nut locks: the patent-office records show hundreds of attempts and devices for preventing the nuts on track bolts from unscrewing. It may fairly be stated that none of these has been in any way successful, either commercially or in practice, which has not in one way or another resembled the Verona nut lock (Fig. 7). This small, but efficient, device acts in three ways,—as an ordinary washer, as a spring forcing the threads of the nut and bolt together, and as a grip, since the ends are bent and form cutting edges which dig into the angle bar and nut, interfering with the tendency of the latter to revolve.

The double-headed rail was abandoned early in this country, and, after coquetting slightly with other forms, we settled down upon the T rail, which seems to be the shape that will ultimately prevail. It has taken some curious forms, and, although it is believed that the present section is based upon a correct interpretation of experience, that same experience most assuredly says that there may be something better coming.

The only remaining feature of the rail pattern in general use ten years ago is its separation into three general divisions,—the head, the web, and the base, which constitute the T pattern; even the chemical composition has been changed, for the carbon has crept up from less than .40 to more than .60, while there are many who advocate a still further advance to .75.

A comparison of two patterns will be instructive. The dotted lines in Fig. 8 shows what was regarded by many as an extremely good section in 1886, and for several years after, where it was used. The

full line in Fig. 8, shows the section of a rail that was first laid in 1888, and typifies what is now considered the best form; this, with the exception of one or two unimportant details, has been recommended by a committee of the American Society of Civil Engineers.

It will be seen that the two most noticeable changes are in the dimensions of the head and the total height, while lesser alterations involve the amount of metal in the base and web. The chief faults in the old section were the internal strains caused by the unequal cooling of the different parts after leaving the rolls; the lack of surface on the top of the head, which allowed the metal to be actually squeezed off by the wheels of a locomotive or car; and, finally, the inadequate vertical stiffness of the rail as a whole. By the change in form shown in the figure (for there is the same quantity of metal, yard for yard, in both sections) these troubles have been largely corrected; since the rail has been in service for many years and continues to fulfil the hopes expressed for it originally, it may safely be considered that one which will be most highly regarded for many years to come, should the present form of track be continued.

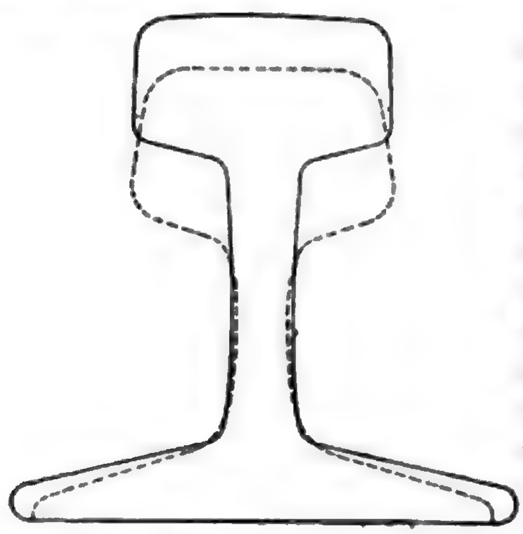


FIG. 8. RAIL SECTIONS.

It has appeared to many railroad engineers of importance, as well as to others of lesser reputation, that a continuously-supported track —that is, without the lateral "sleepers" commonly called "cross-ties"—would offer many advantages over the present manner of construction, which, since the rail is supported only at intervals, is necessarily uneven. Several plans have been proposed, differing so much in detail that it is impossible to describe them here; one method, however, combines so many attractive features that it cannot be ignored. It is the outcome of long-continued experiments by two Germans, Mr. Haarmann and Dr. Vietor, who exhibited it at the World's Fair in 1893 (Fig 9.). The rail has a width of base and a height of about 8 inches, as against a width of base and height of 5 inches in the rail illustrated in Fig. 8: by means of the peculiar section, it is possible to cut off the head and base on the line A–B for about 10 inches back from the ends of the rail without destroying the web; then, by overlapping the ends and bolting them together with six-hole angle bars, a joint is made, which is substantially as strong vertically as the rest of

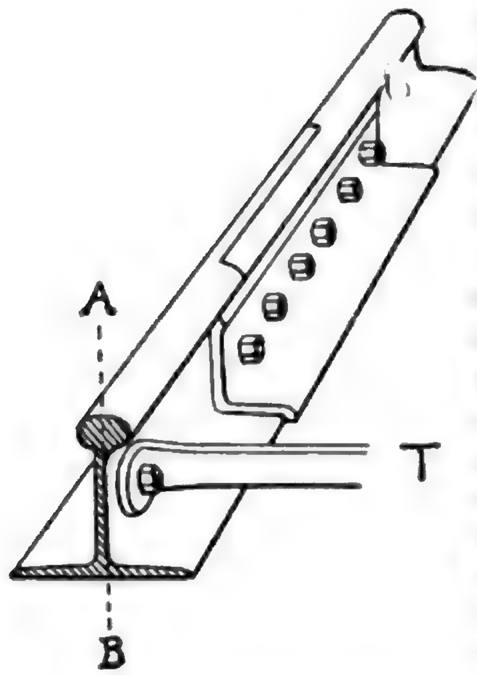


FIG. 9. HAARMAN-VIETOR RAIL.

the rail. The rails on opposite sides of the track are tied together at intervals by the bars, T, to maintain the gage. This rail is laid directly in the ballast without the interposition of sleepers, a thing made possible by the great width of the base; and from long use it has been proved to furnish not only a remarkably smooth track, but one which is also very cheap in repairs. A similar method, it is said, cost for maintenance but twenty dollars per mile per year for a period of ten years on a busy main line. In cost of construction this plan considerably exceeds that of the prevailing one, but, in view of the economies claimed for it, the original expense seems to be of small importance, and it is, therefore, surprising that some move has not been made toward testing it on at least one of our long-established railroads.

In the matter of switches and frogs nothing radical need be expected. The split switch is a beautifully simple and effective device, and, the simpler it is, the more effective. It has an honorable record,

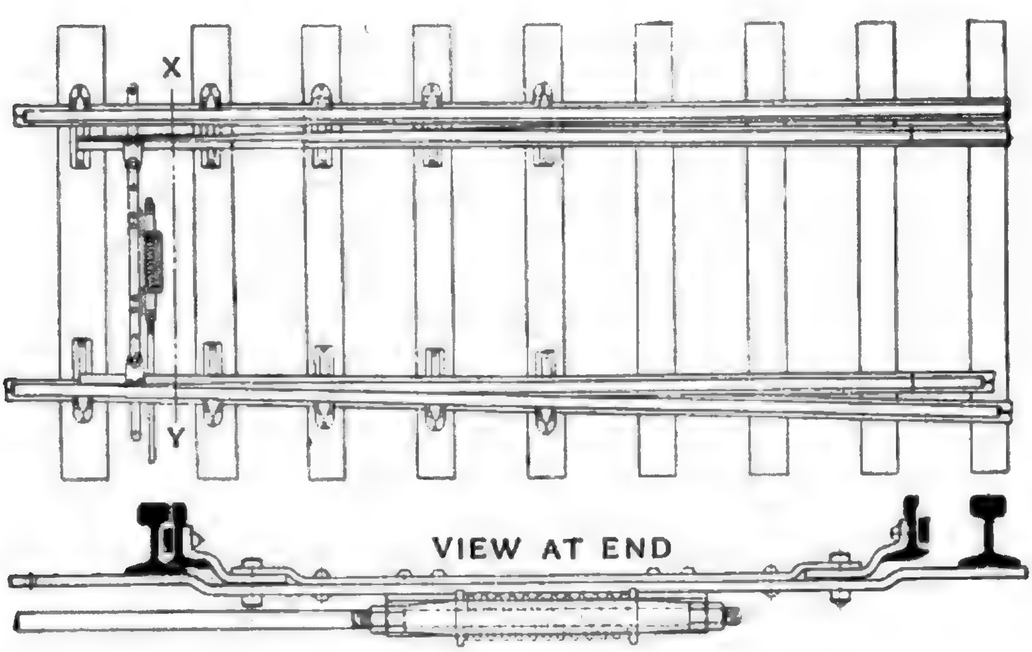


FIG. 10. A SPLIT SWITCH.

and, of the different forms, the one which seems worthiest of description is that which consists of the fewest parts. In Fig. 10 a form is shown which does not contain a nut to unscrew or a weld to break, while, if an adjustment is desired, it can be provided in the rod, which joins the switch to the switch-stand. It differs radically from the ordinary form in one feature; it has only one rod, whereas the usual switches have four or five. Why they should have five rods it is impossible to guess, unless it be for the same reason that we find ourselves provided with a vermiform appendix; time was when they all served a purpose, but, now that their usefulness has passed, they stay simply because they will not drop off of themselves, and no one else seems inclined to interfere with them. The old stub switch needed five rods to hold the sliding rails together, but the split switch rails, being braced on the outside, require no such assistance.

Without doubt, opinion is now fixed in a manner favorable to the spring-rail frog, which, however, differs from the split switch in that it moves automatically within itself, and therefore can never be so

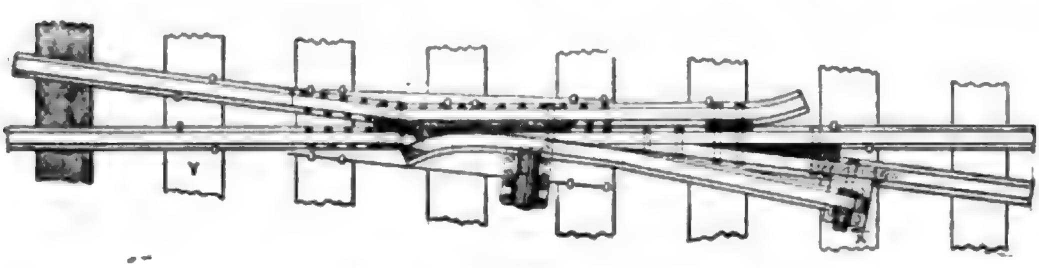


FIG. 11. A SPRING-RAIL FROG.

simple in construction as the switch. Experience, nevertheless, has developed its weak points, which have been fully corrected, and it may be now taken as the standard for high-speed main-track work. It is built in so many different ways that any but a very general description is impossible. Briefly, its purpose is to provide a continuous rail for wheels passing over the fast track. The particular form illustrated in Fig. 11 is modern in design, and represents much that is desirable, but not contained in the ordinary spring rail frog. Its main claim to attention lies in the hinging of the spring rail at X, instead of having the rail from X to Y free to move, as in the most common form.

A recapitulation of the tendencies in maintenance-of-way work resolves itself into two clear propositions.

First, a better understanding and appreciation of the immense importance of the drainage question, which implies a freer use of subsoil tile drains and much more attention paid to the quality and quantity of the ballast used.

Second, increased efforts to secure an immovable track.

MODERN LOGGING IN THE NORTHWESTERN STATES.

By Edward K. Bishop.

LIKE many kinds of business, the logging industry encounters varying conditions in different sections of the country, and must adapt itself to the requirements of the locality in which it is carried on. Even the seasons of activity are by no means identical in different sections of the country, as, in the pineries of Michigan and Wisconsin, the snow of winter is generally considered a necessary factor in logging operations, while, in the forest camps of Oregon and Washington, the bulk of the labor is done during the summer, and the approach of winter is the signal for the close of the year's work, when the men repair to the town.

The cause of the great difference in the manner of logging is to be found in the climatic conditions, the topography of the country, and the peculiarities of the timber to be handled. Manifestly, a method eminently suited to the cypress swamps of the south would be out of place in some mountainous locality of the Pacific northwest, and one well adapted to handle the small eastern timber would be useless among the giant redwoods of California.

A description of the latest and most improved system of logging, as carried on in Oregon and Washington, may be of interest to the general reader who enjoys a glimpse into the workings of an unfamiliar industry, as well as to the lumberman and those connected with some branch of this vast lumbering business, which, in point of capital invested and number of men employed, is the greatest manufacturing industry in our country.

Until recent years, logging in this section was carried on in a rather primitive way, the entire work being done by hand, with the help of oxen. The competition of an increasing number, as well as the necessity of going farther away from the large waterways for timber, brought about the use of steam in logging operations, and led to the adoption of many devices for reducing the cost of transportation and handling to the lowest possible figure. The use of chutes, railroads, and donkey engines was the logical outcome of these conditions, and, in recent years, there has been added what is known as the bull donkey,—a machine previously used somewhat in California, but also adapted to this section. A logger of the old school would be amazed at the ease with which one of these equipments will perform

in a day what would have required weeks of work from his team of oxen.

It should be noted that, in handling the timber of these States, the most important considerations are its large size, the rough nature of the country, and the necessity of doing the work in summer.

While far below the redwood in size, the fir and spruce of this section grow to very large dimensions. The mill man considers nothing a log that is not at least sixteen feet long and sixteen inches in diameter at the small end, and the average log will cut from 1,000 feet to 1,500 feet of lumber, according to the locality. A spruce log that cut over 15,000 feet is on record, and frequently the specifications for foreign shipments call for fir timbers 24 × 24 and 100 feet long.

The topography of the country differs greatly from that of the eastern timber States. The Cascade and Coast Mountains extend through the entire section, making what the Michigan timber cruiser would consider a very rough country. Hill and valley succeed each other so continuously that there is no level land, with the exception of that found on benches, or small plateaus at varying elevations.

The rainy season, which sets in about November and lasts throughout the winter, makes work in the woods very trying for man and beast, and restricts most of the activity to the fine weather of summer. In some low sections the timber is felled in summer, and lies in the woods till it can be brought out by the help of the spring freshet on some small stream; but this is an uncertain and unpopular method of logging.

The first step in all operations in the woods is to fell the timber,—an operation which is unlikely to undergo modification. The timber fellers work in pairs. After selecting a suitable tree, they each cut a notch in its side, into which a spring board about four feet long is inserted. Standing on this, they cut a second notch higher up, and perhaps a third, thus reaching the point at which it is desired to cut the tree. This is done in order to avoid the bulge and accumulated pitch of the butt. Standing on this apparently insecure perch, they use the axe and long double-handled saw, the latter being most in evidence. They become very expert, and drop a tree between two stumps, or at any desired point, in a way that amazes the novice. When leaning heavily in one direction, a tree can be made to fall in exactly the opposite by the use of wedges.

Close upon the fellers come the cross-cut sawyers, who cut the trunk into logs of convenient length, and the barkers, who, with axe or spud,—an iron bar with flattened end,—clean the log down to the white wood.

The next step is to gather the logs from their isolated positions to

a central point,—yarding them out, the process is called,—and this, in times past, was always performed by oxen, which extricated them from even the most difficult positions with great skill. In the modern camp there is a donkey engine of from 25 to 50 h. p. for this purpose. A cable is run from the donkey to the log to be pulled out, and a dog, or iron hook, in the end is driven deep into the wood. At a signal from the hook tender, the log is pulled through all obstructions to the puffing engine. By means of blocks a pull in almost any direction can be made. The donkey is mounted on a sled, and can easily be changed in position by attaching the cable, which is from 200 to 500 feet long, to some secure stump, whereupon it will pull itself over the ground.

In many places, after being yarded out, the logs are formed into trains by being hitched end to end, and taken away by a long team of oxen under the direction of the "bull puncher," who, during the operation, makes free use of a picturesque vocabulary.

Wherever logs are hauled through the woods, skid roads are found, the road-beds so substantial in construction that they stand an immense amount of travel and, long after the departure of the logger, form a monument to his industry. Though much can be said in favor of their permanence and usefulness, they can hardly be considered good roads for pleasure-vehicles, as, at every five or six feet, a skid or log, ranging from a foot in diameter upward, according to location, stretches over the surface. The train of logs slides on the well-greased face of these skids with the least possible friction. The skid roads ramify through the woods in all directions, up hill and down, curving around or cutting through obstructions, often crossing little streams on log bridges as strong as they are rough. The skill of the civil engineer is required in those who lay out these roads, as a false direction, a too sharp curve, or an abrupt descent means trouble and additional expense.

When the timber near the mills and waterways began to be exhausted, and operations were carried on at a greater distance, necessitating a long and expensive haul by cattle on a skid road, logging railroads began to be introduced. These are found of both narrow and broad gage, and, with engines built for power rather than speed, they can handle an immense number of logs. The logs are loaded usually on very heavy trucks, the engine, by means of a cable, furnishing the power to roll them into position. The latest addition to logging appliances has been what is known as a bull donkey, which furnishes tremendous power for transporting logs, and combines with it the desirable feature of working a considerable area of country.

Equipments vary in detail in different localities, but a description

FELLING WITH THE SAW.

of one, located on the side of Larch mountain in Oregon near the far-famed Columbia river, will give an excellent idea of the typical logging camp of Oregon and Washington, with all the modern and progressive methods in operation, and will also bring out some unique features that are found in no other logging-plant in the country.

After being cut and yarded in the usual way, the logs are transported successively by a bull-donkey, a chute, and a railroad. The

YARDING LOGS WITH THE DONKEY.

TRANSPORTING WITH OX-TEAMS.

first is located farthest out in the woods, and is an immensely powerful machine, with two drums loaded with cable. Some idea of its size may be gained by considering that the larger drum, which is 30 inches in diameter and 5 feet between flanges, with its gear wheel, weighs five tons. A battery of two boilers supplies steam to the cylinders, one on each side, 10 inches by 16 inches in size. From the smaller drum, a light cable extends along a skid road to some point within a mile and a half of the donkey, where it passes over an idler and, returning to the large drum, is fastened to its cable, three-fourths of an inch in diameter, thus forming the means of drawing the latter out into the woods. Here it is attached to a train of logs, and, on being rewound on the spool of the donkey, easily pulls its heavy load over the skids to the engine. The power is so applied that 30,000 feet of logs can be moved at one time, a load weighing about 120,000 pounds. Up to this point, the power is applied in the same manner as with the small yarding donkey, the only difference being the increased load and distance; but here the method becomes novel.

THE BULL DONKEY.

From the power house runs a chute for three quarters of a mile, the greater part on a six per cent. grade and with a steep descent at the lower end. Chutes, for bringing logs down from a hill, are of frequent occurrence, and are formed usually of three continuous logs, making a kind of trough, one at the bottom and the other two elevated

THE LOG CHUTE, LOOKING FROM THE BULL DONKEY.

to form the sides. These are sufficiently steep for gravity to furnish the motive power. The chute in question, however, is very different, as the logs will not move of themselves for the greater part of the way. So far as the builders know, there is nothing just like it in the country. Elevated for the entire distance above the ground, it is supported on a trestle much like that used in railroad-building. There are no ties on the stringers, the latter being planked over to form a continuous surface for the logs to slide upon, with a light guard-rail on either side to prevent them from rolling off. An endless cable extends from the

donkey to the crest of the hill, half moving on the surface of the chute, the returning portion being below. At the donkey it makes four turns around two grooved wheels, one attached to the main shaft and the second a snub wheel. This is done in order to apply the power to the cable without slipping. A reproduction, on a small scale, is thus made of the great cable-car systems of San Francisco and Chicago. Instead of pulling cars through the crowded streets of a metropolis, this cable transports trains of logs through the solitary depths of the forest. Unlike most places where a cable is used, the hold is taken at the rear end of the last log, which pushes the others ahead of it. When the logs run faster than the cable, the grip automatically loosens, only to take a fresh hold on overtaking the train. Thus they move onward, till the top of the hill is reached. The chute terminates in a large pond, formed by damming the cañon at this point. As the logs come upon the steep decline, they start forward, gaining headway as they advance, till a terrific speed is attained before they reach the pond, where they bury themselves in the water and throw a cloud of spray to a great height. The drop in 1,200 feet is about 300 feet. As the water at the end of the chute is too shallow to prevent the logs from being injured by digging into the sand and rocks beneath, the accomplishment of such prevention was a problem. A gradual upward curve in the end of the chute keeps the logs from sinking too far, but

THE FOOT OF THE CHUTE.

LOG RAILROAD, CHUTE, AND POND.

it was difficult to make a termination that would resist the tremendous pressure. Heavy timbers were moved and broken like straws. The solution arrived at was the placing of a heavy log to receive the impact. This is more than a hundred feet long, embedded in the bottom of the pond under water, with the upper face hewed slightly concave to receive the descending log, and so fastened with cross beams, railroad iron, and rocks that it seems as if an earthquake would fail to move it.

The bull donkey and cable system form a most satisfactory and economical means of handling logs. As can be readily seen, the direction of the cable extending from the power-house can be easily changed to reach any point in a radius of a mile and a half. A small donkey is used to draw logs within reach of the cable. It is estimated that over fifty million feet of logs are directly obtainable in the territory tributary to this chute.

The method employed in carrying the logs onward from the point which they have now reached is by a railroad several miles in length. It follows closely the course of a little mountain stream boiling down the cañon, crossing it many times on bridges, and with a plentiful supply of curves, one of them an exact horse shoe in shape. In construction it closely resembles that of any mountain railroad. The grade is so steep, being 6 per cent. on the average and with one short

stretch of 12 per cent., that means had to be devised to prevent the locomotive from running away with a loaded train. The means consists in covering the ties between the rails with boards running lengthwise, and on this surface, rendered slippery by the application of grease and water, having the engine pull a train of logs, hitched end to end, exactly as is done by the oxen on the skid road. It is the only place in the country where logs are pulled by a locomotive in this manner, and, at first thought, it seems that the high rate of speed and numerous curves would cause dire mishaps; but several years of successful operation have proved that the slight elevation of the rails forms a sufficient guard to keep the logs in the track. A train under way appears exactly like a huge snake winding down the cañon. From five to ten thousand feet of logs constitute a load, and an average speed of fifteen miles an hour can be maintained by the eighteen-ton locomotive. This logging equipment belongs the Bridal Veil Lumbering Company, and supplies logs to their mills.

In the majority of cases in Oregon and Washington, logs are put into some tributary of one of the large waterways, like the Columbia river or Puget sound, and are towed in rafts to the mill where they are to be converted into lumber. The vast belt of timber tapped by the above-mentioned logging plant could never have been brought to market in that way, as the rugged mountains skirting the Columbia

LOCOMOTIVE UNDER WAY WITH A TRAIN OF LOGS.

prevented the getting of logs to the water. Years ago, representatives of large mill companies examined the timber, and, though the quality was pronounced excellent, declared that it was practically valueless, on account of its inaccessibility. It remained for later comers to demonstrate that new conditions can always be successfully met by new methods.

Their plan was to place the saw-mill back in the mountains, where logs could be brought to it, and carry the lumber from the mill to a point where it could be shipped by a flume. Wise heads of the lumber business declared that timbers would never stay in a flume that had to be built with a fall of eight hundred feet to the mile, but trial disproved this, and lumber of all dimensions, up to 16" × 16" and 60 feet long, has been successfully handled. The flume is V-shaped, and carries a stream of water, diverted from the creek, which serves to keep the lumber from being marred by contact with the sides, and also forms a medium that prevents the speed of the descending timbers from being accelerated beyond a certain point. Lumber is thus successfully carried a mile and a half in this flume in four minutes.

TAKING A LOAD OF LOGS FROM THE POND.

At present, there are few mills so located that their product must be brought out in this way, but there are many places where such a

method of transportation is the only feasible one. As timber becomes more valuable with the passage of time, the sound of the logger's axe will be heard in many a belt of fine growth now considered very remote.

Logging is being followed in a less haphazard manner than in previous years, and the study of earnest and thoughtful men is reducing it to a more exact science than it was in the days when the construction of the transcontinental railroads, and the consequent rush of settlers, caused such a demand for lumber that almost anything sawed out of a log could pass by that name.

The recent years of depression in the lumber industry, of course, reacted directly on the loggers, and demonstrated anew "the survival of the fittest," but the final result will doubtless be beneficial in causing closer attention than ever to be paid to ways and means, and in evolving the best possible methods of handling that most valuable gift of nature, the timber of her forests.

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

II.

HAVING considered the troubles resulting from the use of certain boiler waters containing corrosive agents, we now may turn our attention to the impurities causing the formation of scale or incrustations.

Scale-making matter may be held in water in two different ways; in mechanical suspension, as small floating particles, or in chemical solution. The earthy or organic matter in suspension may be removed by settling or by filtration; but dissolved impurity requires treatment either by chemicals or by heat, the result being that precipitation takes place, whereupon we have the condition first named,—matter in mechanical suspension which must be cared for in some efficient manner before our treatment can be considered successful or complete.

When "muddy" water is used for boilers, too much care cannot be exercised to remove the earthy impurities. These frequently consist of clay, which, when mixed with the average precipitated matter in boilers, forms a hard, resisting scale, not unlike Portland cement. Finely-divided vegetable matter, which occurs suspended in the water of running streams, is sometimes beneficial when introduced into boilers along with untreated water; it often prevents the formation of a hard scale. Nevertheless, it is not always safe to allow these minute, solid organic particles to remain, for Lefévre proved conclusively that a rapid pustular corrosion sometimes found in boilers using such water is due to the oxidation of these particles, developing pectic acid.

One of the most important groups of salts described in our chemistries is the carbonates. They are most widely distributed, being found in considerable quantities in nearly every section of the globe. Thus carbonate of lime is found as limestone, marble, chalk, mollusk shells, and coral deposits. Carbonate of magnesium occurs frequently as magnesite, and, in combination with carbonate of lime, as dolomite, forming huge mountain masses.

Carbonate of iron exists in nature as siderite, or spathic iron. The "clay ironstone" is abundant in coal measures. Spathic iron also occurs in considerable quantities in gneiss and mica schist.

All of the carbonates are formed by the union of carbonic acid (CO_2) with some one of the metallic oxids, such as calcium oxid ($Ca\,O$), magnesium oxid ($Mg\,O$), iron oxid ($Fe\,O$), etc. The me-

tallic oxids just named, in combination with carbonic acid, form respectively carbonate of calcium, or, as it is frequently termed, carbonate of lime ($Ca\,CO_3$); carbonate of magnesium ($Mg\,CO_3$); and carbonate of iron ($Fe\,CO_3$).

Generally speaking, of all the scale-formers precipitated from boiler waters, none occurs so frequently or in so large proportions as carbonate of calcium; second to this comes carbonate of magnesium; while carbonate of iron occurs much less frequently than either of these, and never in large proportion.

These carbonates are but slightly soluble in water. For instance, carbonate of calcium seldom exists in water in greater quantity than one grain per United States gallon, although, under conditions occasionally found, a gallon may dissolve somewhat more than two grains. Carbonate of calcium is more soluble in cold water than in hot, and the presence of salt (chlorid of sodium) dissolved in the water increases its solubility somewhat. The same statement practically applies to carbonate of magnesium, but, when both are present, the total held in solution never exceeds the maximum quantity of either which an equal volume of water is capable of dissolving. Carbonate of iron is practically insoluble in water.

How is it, then, that these carbonates are found in large quantities in chemical solution in boiler waters? The explanation is to be found in the fact that gases are very soluble in water and, when present, aid it in dissolving the salts in question. Wanklyn states, in his "Water Analysis," that "in many natural waters there is more carbonic acid, in one shape or another, than any other single foreign material." This acid alone, under ordinary pressures and temperatures, exists in the form of a gas. It is very widely distributed in nature, forming a constant and essential constituent of the atmosphere, and is also contained in the soil, being one of the chief products of organic decay. Some is absorbed by the falling rain, and a very much larger quantity is dissolved as the rain-water passes through the soil. The wide and enormous distribution of the various carbonates, such as limestone, dolomite, and spathic iron, has already been noted. Now, although the carbonates are practically insoluble in pure water, they are very soluble in water containing carbonic acid. The solution does not take place, however, until some of the carbonic acid has been appropriated by the carbonate (a quantity equal to that already existing there), thus forming what is termed a bi-carbonate (or double carbonate). Thus carbonate of calcium becomes bicarbonate of calcium, which may be held in solution in the ratio of 51 grains to the gallon. Bicarbonate of magnesium is even more soluble, 362 grains per gallon being a possible solution.

Although 91 grains of bicarbonate of iron per gallon may be dissolved, natural waters generally contain but little of it.

The rain, then, generally reaching the earth charged with carbonic acid, and picking up and dissolving still more carbonic acid as it afterward passes through the soil, seldom escapes contact with some of the carbonate rocks, which dissolve in it as a lump of sugar dissolves in tea. Immense quantities of rock have thus been gradually dissolved ; indeed, it was in this way that the Mammoth Cave in Kentucky and the Luray Caverns in Virginia were formed.

After passing over these rocks and forming new solutions, these waters reach the surface again, forming the constant supply of our rivers, lakes, and wells, from which we get our boiler feed-waters. The bicarbonates are very unstable, and are known to exist in water only in the solutions just described. They are very much more soluble in cold water than in hot, because a rise in temperature drives off the excess of carbonic acid and leaves behind the insoluble monocarbonates (or single carbonates). When a temperature of 180° F. is reached, a large percentage of the bicarbonates is precipitated as insoluble monocarbonates, and at 290° (the temperature of steam under 43 pounds, gage pressure) the precipitation is complete. This readily accounts for the large deposits in boilers where these salts are present in the water. As will be seen later, various apparatus have been constructed in which the feed-water is heated before passing to the boiler, and thus made to deposit most of its carbonates in the apparatus instead of precipitating them in the boiler.

The chemical treatment of these carbonates requires separate consideration. Let us take first bicarbonate of calcium. The removal of the salts of lime, magnesium, and iron is sometimes called the softening of water. The art of softening water for washing appears to have been known since the remotest period of antiquity, but not until 1841 was it successfully practised on a large scale. In that year the late Dr. Thomas Clark, of Aberdeen, Scotland, took out a patent for his well-known and beautiful process of softening water, and this has been the basis on which most of the more recent processes have depended.

The Clark process depends upon a very simple chemical reaction. One pound of carbonate of calcium is composed of nine ounces of lime and seven ounces of carbonic acid. By burning this one pound (in the form of chalk, marble, or limestone) in a lime-kiln, the seven ounces of carbonic acid may be expelled, leaving behind the nine ounces of lime, which is known as building lime, or quicklime. Although carbonate of calcium is scarcely soluble in water, the new product (nine ounces of lime) may be completely dissolved in forty gallons of pure water.

Now, taking another pound of carbonate of lime, we may make this soluble in water in another way by adding to it a second seven ounces of carbonic acid.

In order to precipitate the bicarbonate thus formed, by the Clark process, we have but to add to this solution the nine ounces of lime which we obtained from the lime-kiln, and the free lime will combine with the second portion of carbonic acid in the bicarbonate of lime, giving two pounds of the simple monocarbonate of lime, which, being insoluble in water, is precipitated at once in a floury form, leaving, when settled, a practically clear water. True, it will still contain monocarbonate of lime in the ratio of a little more than two grains to the gallon, but this small quantity is not noticeable in a boiler water.

When treating water by this process, care must be exercised not to introduce too much lime, as this will produce bad results; on the other hand, enough lime must be used to act on the entire bicarbonate. When using quicklime for softening, it should first be slacked, by pouring water upon it until it ceases to disappear by union with the quicklime. This forms hydrate of lime, and a further addition of about three times this quantity will form lime water, which is most desirable for this purpose. Dr. Clark recommended, to determine the results obtained in the treated water, a test with nitrate of silver. A more delicate test consists in using a solution of cochineal, whose natural yellowish red color turns violet in the presence of alkalies. Other agents are also used to show, by color or its absence, whether there is an excess of lime in the softened water.

The lime process of softening water is extensively used in England, Germany, France, Austria, and Belgium, but, as Americans have been very backward in the matter of treating properly their boiler waters, its use in this country is very limited. The purest obtainable quality of quicklime should be used. Much of the ordinary "building lime" contains impurities such as flint, stone, burnt clay, etc.

This process is expressed chemically as follows:

Bicarbonate of Calcium	and	Hydrate of Lime	form	Carbonate of Calcium	and	Water.

$$\mathrm{Ca\,H_2\,(CO_3)_2 + CaH_2O_2 = 2\,(Ca\,CO_3) + 2\,H_2O}$$

Notwithstanding the apparent simplicity of this process, it requires great care to conduct it successfully. Should an excess of lime be added, it certainly will form a scale as troublesome as that which it is the purpose of the process to prevent,—in some cases, indeed, a harder and worse one.

The use of soda for the purification of water is called the soda process; either caustic soda (hydrate of soda) or carbonate of soda may be used, and separately or together.

In the treatment of water containing simply bicarbonate of lime, caustic soda alone should be used, but this treatment is not as desirable as the lime process already described, being neither as cheap or as efficient, and not as easily handled. Caustic soda, on being exposed to the air, rapidly absorbs moisture, becoming a soft slush, and, when it comes in contact with the hand, it dissolves the skin by its caustic power, causing painful sores. Notwithstanding these drawbacks, it is very useful in water purification when other impurities appear.

The reaction which takes place when a solution of bicarbonate of calcium is treated with caustic soda is shown thus:

Bicarbonate of Lime	and	Caustic Soda	form	Carbonate of Calcium	and	Carbonate of Soda	and Water.
$Ca\ H_2\ (CO_3)_2$	$+$	$2(Na\,OH)$	$=$	$Ca\ CO_3$	$+$	Na_2CO_3	$+\ 2H_2O$

In other words, the carbonate of calcium is precipitated, while the carbonate of soda remains in solution; very little of the latter will be precipitated at ordinary boiler temperatures, provided the boiler is "blown off" occasionally to prevent the solution from becoming too dense by concentration. This solution of carbonate of soda is very useful in water holding any of the sulphates. Great care must be observed in using caustic soda. If used in excess, it causes a boiler to foam badly, and also readily attacks the fittings.

Next let us consider the carbonate of magnesium or, more properly speaking, the solution of bicarbonate of magnesium found so frequently in boiler waters. The methods of its removal are practically identical with those of removing bicarbonate of calcium, but this salt is not generally turned into the monocarbonate of magnesium ($Mg\ CO_3$) when chemically treated, but into the hydrated oxid ($Mg\ H_2\ O_2$). When water containing bicarbonate of magnesium is heated to 180° F., the greater part is precipitated as a monocarbonate, and at a temperature of 290° there remains in solution in the water only a fraction more than two grains of monocarbonate of magnesium to the gallon, and a part of even this small quantity may disappear in the presence of carbonate of lime. This decomposition frequently proceeds even further, more carbonic acid being expelled, leaving behind magnesium hydrate. This acts in the scale as a powerful cement, especially when sulphate of lime is present.

The reaction that occurs when bicarbonate of magnesium is treated by the lime process is expressed by the following formula:

Bicarbonate of Magnesium and Hydrate of Calcium form Carbonate of Magnesium and Carbonate of Calcium and Water.

$$Mg\ H_2\ (CO_3)_2 + Ca\ H_2O_2 = Mg\ CO_3 + Ca\ CO_3 + 2\ H_2O$$

The precipitate, then, consists of carbonate of magnesium and carbonate of calcium. Both hydrate of magnesium and hydrate of cal-

cium may be formed, if their respective carbonates are deposited on such parts of the boiler as are presented to the higher temperatures. In such cases these salts lose their carbonic acid, thus leaving the oxids, which soon unite with water and form the hydrates.

It is not advisable to treat bicarbonate of magnesium with the soda process, unless sulphate of calcium or of magnesium is also present.

We now come to the consideration of bicarbonate of iron. This, practically speaking, is the only form in which we find iron in natural waters. The solution is not a stable one; it decomposes rapidly on boiling, and slowly when exposed to the air, giving a reddish precipitate of hydrated oxid of iron (or iron rust). This salt is sometimes largely removed by splashing the water over rocks or twigs in such a way that the air comes in contact with the largest possible surface, thus hastening this process of oxidation and rapid deposit of iron.

Bicarbonate of iron can be treated by the lime process, but, if so treated, it easily yields up all its carbonic acid, and eventually is precipitated as hydrous oxid of iron, coloring the entire precipitate yellow. This hydrous oxid is very insoluble in water.

Next to the carbonates, sulphates occur most frequently in boiler waters, chief among them being sulphate of calcium. Probably no scale has proved more destructive or troublesome in steam boilers than that resulting from the precipitation of this salt.

The sulphates are formed when sulphuric acid acts on the metallic oxids, which it readily does. Most of them are very soluble in water. In nature we find sulphate of calcium widely distributed, either occasionally in the anhydrous state,—*i. e.*, uncombined chemically with water,—as the mineral anhydrite, or, more commonly, hydrated, as gypsum. Gypsum is sometimes known under other names, according to its crystalline structure,—selenite, satinspar, alabaster. When gypsum is heated to a point between 230° and 250° F., it loses three-quarters of its water rather quickly, and becomes the well-known plaster of Paris. The anhydrous sulphate is nearly insoluble, but the hydrated, with water at 95° F., dissolves in the ratio of 148 grains to the gallon. Its solubility in water at other temperatures is shown below.

At	32°	F.	120	grains	per	gallon
"	68°	"	141	"	"	"
"	122°	"	147	"	"	"
"	158°	"	142	"	"	"
"	212°	"	127	"	"	"
"	240°	"	10.5	"	"	"
"	250°	"	9	"	"	"

" from 248° to 302° it is practically insoluble.

When the temperature of the water is raised above 302° F. (corre-

sponding with 55 pounds' gage pressure of steam), practically all of the sulphate of calcium will be precipitated.

The hydrous sulphate of lime is dissolved in water by the solvent power of the water itself, and not through the agency of carbonic acid or any other gas, and thus mere boiling at atmospheric pressure is not sufficient to cause it to be precipitated. For this reason it gives what is known as permanent hardness to water.

When the hydrous sulphate of calcium is precipitated, it loses one half of its water of crystallization, and, on reaching the heated boiler plate, it loses the other half. Thus it becomes anhydrite, and it is this change in crystalline form which binds the deposits previously precipitated into hard, compact masses.

Owing to the great solubility of sulphates, they occur very frequently in water that has made a passage through the earth. If we could trace all our solutions of sulphate of calcium to this direct source of supply, we doubtless would be troubled little, comparatively speaking, by this salt. Sulphuric acid is frequently present, in the free state, in rain and other natural waters, as has already been explained. This acid not only acts readily on the metallic oxids (converting them into sulphates), but also decomposes carbonates with the greatest ease, expelling the carbonic acid with effervescence; thus, when acting upon carbonate of calcium, it transforms it into sulphate of calcium.

When water containing free sulphuric acid passes through limestone districts, either subterranean or on the surface, sulphate of lime is thus formed by the mere splashing against the limestone rocks.

Sulphate of lime is also formed when waters containing free sulphuric acid are mingled with waters containing solutions of bicarbonate of lime, an exchange of the carbonic acid for sulphuric acid taking place. This sometimes happens in boilers when certain chemicals are introduced.

In treating water containing sulphate of calcium, the first step must be the conversion of the salt into the insoluble carbonate of calcium. The lime process is in no way applicable to the treatment of sulphate of calcium. Here the soda process is most applicable; either caustic soda or carbonate of soda may be used, and separately or together. When carbonate of soda is used alone, there should be no free carbonic acid or bicarbonates present, as these would furnish the carbonic acid necessary to form the soluble bicarbonate the moment the insoluble monocarbonate of calcium appeared. This trouble is avoided by adding sufficient lime water to absorb the excess of carbonic acid gas.

The reaction taking place when the carbonate of soda is used is shown in the following formula:

Sulphate of Calcium and Carbonate of Soda form Carbonate of Calcium and Sulphate of Soda.

$$Ca\,SO_4 + Na_2\,CO_3 = Ca\,CO_3 + Na_2\,SO_4$$

The carbonate of calcium, being insoluble, is precipitated, while the very soluble sulphate of soda remains in solution at all temperatures reached in boiler practice. It can be precipitated only by concentration, but an occasional opening of the blow-off cock will prevent this. This reaction is somewhat sluggish; for rapid precipitation it needs the assistance of heat. This use of carbonate of soda is not as satisfactory as the use of caustic soda, which is more energetic, rendering heat less necessary to the production of good results. In using caustic soda, great care should be observed to avoid an excess, as it will cause no little trouble from foaming, and, when concentrated, will attack the brass and copper fittings of the boiler.

Soda, as well as a few of the other very soluble salts, has a strange way of passing through the seams and joints of boilers, notwithstanding the fact that these are made absolutely tight for steam and water. This is especially true when these salts are somewhat concentrated. I have seen large deposits of these salts collected around cover joints, and in one case recently, actual stalactites had been formed, hanging like icicles from the joints through which this solution had oozed.

In nature we find magnesium sulphate ($Mg\,SO_4$) occurring in the minerals kieserite ($Mg\,SO_4H_2O$) and epsomite [$Mg\,SO_4 + 7\,(H_2O)$]. Kieserite is found in the Stassfurt salt beds, and epsomite in many of the limestone caves in minute crystals mingled with the earth; in the Mammoth Cave, Ky., it adheres to the roof in loose masses, like snow-balls. It has also been found as a coating on the walls of gypsum quarries. Kieserite is not easily soluble, and, as it occurs so seldom, it is scarcely worth attention. Epsomite is very soluble. It is identical with the well-known cathartic, epsom salt.

The supply of sulphate of magnesia directly from the mineral is very limited, the greater part of the solutions found in natural waters being formed by the contact of sulphuric acid with magnesium oxid or with carbonate of magnesium in a manner closely analogous to the formation of sulphate of calcium.

It occurs, however, in boiler waters far less frequently than any of the impurities we have thus far discussed, and its behavior is very different from that of sulphate of calcium, largely on account of its much greater solubility at all temperatures, and especially of the rate of increase in its solubility as the temperature is raised. Sulphate of magnesium is not corrosive or injurious to the boiler parts, and does not cause foaming; therefore, by itself, it cannot be considered very

objectionable; but, when present with lime salts, it is often troublesome, hindering their removal. To illustrate this, let us suppose that we have a solution of both sulphate of magnesium and bicarbonate of calcium. To precipitate the latter, we introduce a solution of hydrated oxid of calcium (lime water). This acts on the sulphate of magnesium as well, as shown in the following formula:

Sulphate of Magnesium and Hydrate of Calcium form Hydrated Oxid of Magnesium.

$$MgSO_4 + CaH_2O_2 = MgH_2O_2$$

and Sulphate of Calcium.

$$+ CaSO_4$$

Thus is produced the very objectionable sulphate of lime, and with it is precipitated the hydrated oxid of magnesium, which will make much harder scale than the original water would have made.

Soda certainly should have been used in this case, in preference to lime. Carbonate of soda occasions the following reaction in cold water:

Sulphate of Magnesium and Carbonate of Soda and Water form Carbonate of Magnesium

$$5\,(MgSO_4) + 5\,(Na_2CO_3, + 10\,(H_2O) = 4\,(MgCO_3),$$

and Hydrated Oxid of Magnesium and Sulphate of Soda and Carbonic Acid and Water.

$$MgH_2O_2 + 5(Na_2{\cdot}SO_4) + CO_2 + 9\,(H_2O)$$

As the sulphate of soda and carbonic acid remain in solution in the water, the precipitate will be $4\,(MgCO_3)$, $MgH_2O_2 + (H_2O)$.

In treatment with carbonate of soda, enough lime water should be added to combine, not only with the carbonic acid, but also with the carbonic acid in the carbonate of soda, thus partially producing a caustic soda. This treatment, however, is inferior to the treatment with caustic soda. Where the steam pressure in boilers exceeds 225 pounds, a new complication may be looked for when sulphate of magnesium and bicarbonate of calcium are present together, as, according to Collet, these salts react upon each other at a temperature of 392° F., carbonate of magnesium and sulphate of calcium being precipitated.

In boiler waters we frequently find one or more of the metallic chlorids present, such as chlorid of sodium ($NaCl$), chlorid of magnesium ($MgCl_2$), chlorid of calcium ($CaCl_2$), and chlorid of potassium. Chlorid of sodium is simply common salt, such as is used in flavoring food. It is very soluble at all temperatures, increasing slightly as the temperature is raised, as may be seen by the following table:

At	32°	Fahr.	20,849	grains	NaCl	dissolved	per	gal.
"	68°	"	21,014	"	"	"	"	"
"	122°	"	21,598	"	"	"	"	"
"	167°	"	22,182	"	"	"	"	"
"	194°	"	22,767	"	"	"	"	"
"	220°	"	23.349	"	"	"	"	"
"	239°	"	23,640	"	"	"	"	"

Chlorid of sodium is frequently found in boiler waters, though seldom in large quantities. Its source of supply is very great. Immense deposits are found in many parts of the world, in the form of rock salt. It also occurs very widely distributed in smaller quantities, mixed in shales and marls, and frequently associated with gypsum, anhydrite, clays, and sandstone.

It is the principal solid constituent of sea-water, and many boilers located near the coast find in their water-supply chlorid of sodium coming from wells, inlets, rivers, etc.

Owing to the great solubility of "salt" in water, it, theoretically, will not be precipitated to form a scale until after it has been so concentrated that more salt will be found in each gallon than that contained in the saturated solution (as shown in the table). Practically, more or less salt is usually found (in small quantities) in nearly all scale where salt is contained in the water, even though a saturated solution is not approached.

Salt solution, like soda, has a persistent way of working through joints. I have seen this "leakage" continue until considerable deposits of salt had formed on the outside of the boiler.

Salt water for boilers has not been treated chemically by any practical methods. It can be used safely in a boiler with frequent use of the blow-cock, by which its density can be kept well above the point of precipitation. It is necessary to watch the density of such water in the boiler very carefully by use of a special hydrometer. This system, unfortunately, causes more or less waste of fuel, on account of the considerable quantity of hot water necessarily wasted in the blowing-off process, and this has led to the putting-in of condensing apparatus in such steam plants, by which all the steam that can be collected, after use, is condensed, the condensed water being then used in the boiler. An apparatus known as an evaporator is sometimes used, in which the salt water is heated by the use of steam from the boiler, and the fresh water distilled off is carried to the boiler. The salt and other solid matter that may be left behind in the evaporator is easily removed periodically. This apparatus is generally used to furnish "make up" water, in connection with the condensing plant. The steam which is lost by waste, etc., is thus replaced.

Unfortunately, exhaust steam from engines, pumps, etc., frequently carries oil with it, which is apt to accompany the condensed steam (or water) into the boiler, where it is a source of much trouble.

A solution of the chlorid of magnesium is frequently found in boiler waters. Of all scale-making substances, there is probably none so productive of corrosion as this one. The affinity of the magnesium and chlorine being very weak, these elements are separated at

nearly all boiler temperatures and pressures, hydrochloric acid being given off and magnesium hydrate remaining behind. Magnesium hydrate is very frequently found in boiler-scale, partly formed by the action just described, and partly from the precipitation of magnesium carbonate, which then loses its carbonic acid and forms the hydrate.

The formula showing the decomposition of the chlorid of magnesium and the description of the following corrosive action was given in the first article on this topic. Chlorid of magnesium is always present in sea-water, and in the inland seas and salt lakes. Water from brine springs almost invariably contains magnesium chlorid in solution. It occurs in the water of other springs.

When magnesium oxid, or carbonate of magnesium, is dissolved in hydrochloric acid, magnesium chlorid is produced, and doubtless this action takes place in nature, and is responsible for at least a portion of this supply.

Magnesium chlorid is very soluble in water: thus

At	32°	F.	30,470	grains	$Mg\,Cl_2$	dissolved	per	gallon.
"	60°	"	75,882	"	"	"	"	"
"	212°	"	213,645	"	"	"	"	"

If this were a more stable salt under boiler temperatures, it would give but very little trouble, owing to its great solubility. When present with a solution of chlorid of sodium, it is much less liable to decomposition, and for this reason it has been suggested that salt be added to water containing magnesium chlorid. Fortunately many waters contain sufficient carbonate of calcium to neutralize the hydrochloric acid by their alkalinity, and by this means corrosion is often avoided.

Collet recommends the treatment of chlorid of magnesium in the same manner as sulphate of magnesium. He states that lime will precipitate the hydrated oxid of magnesia, and leave the chlorid of calcium in solution. "Provided that there is no sulphate of magnesia remaining in the water so treated, the chlorid of calcium will not give rise to scale or deposit, and is not objectionable." "There are, however, very few cases where chlorid of magnesium can usefully be treated with lime alone, and, practically, only soda is used for this purpose."

Chlorid of calcium, besides occurring along with chlorid of magnesium, the mineral tachhydrite ($Ca\,Cl_2 + Mg\,Cl_2 + 12H_2O$), is much more widely distributed in the mineral apatite [$3\,Ca_3(PO_4)_2 + Ca\,Cl_2$]. Analysis of boiler waters very seldom shows any large quantities of this salt, three or four grains per gallon being a maximum, while smaller quantities are more frequently found. It is generally present in the waters of springs and rivers, and consequently in sea-water.

The chlorid of calcium is very soluble: thus

At	32°	Fahr.	29,186	grains	$Ca\ Cl_2$	dissolved	per	gallon.
"	60°	"	38,525	"	"	"	"	"
"	212°	"	90,475	"	"	"	"	"
"	356°	"	189,713	"	"	"	"	"

No scaling trouble will result from the presence of this salt in boiler water (due to the solubility increasing with the temperature), provided the solution is not allowed to become too greatly concentrated. It is, however, unfortunate that, when the chlorid of calcium becomes concentrated at a high temperature, its contact with the iron causes decomposition, and the chlorine attacks the shell. When this salt is present with sulphate of magnesium, a reaction is liable to take place, the sulphuric acid (in the sulphate of magnesium) replacing the chlorine (in the calcium chlorid), and forming the corrosive chlorid of magnesium and the scale-making sulphate of calcium.

The treatment of the chlorid of calcium should be the same as that of sulphate of calcium, the reaction, when carbonate of soda is used, being:

Chlorid of Calcium and Carbonate of Soda form Carbonate of Calcium and

$$Ca\ Cl_2 \quad + \quad Na_2\ CO_3 \quad = \quad Ca\ CO_3 \quad +$$

Chlorid of Sodium

$$2\ (Na\ Cl)$$

Chlorid of potassium occurs in boiler waters even less frequently than chlorid of calcium, and generally in less quantity. It occurs in a number of the mineral springs, and a small amount is found in sea-water. It is very soluble at all boiler temperatures, and no scale will be precipitated, unless the solution is greatly concentrated.

The nitrates in boiler waters are seldom a source of trouble. They are simply salts of nitric acid, and include nitrate of calcium $Ca\ (NO_3)_2$, nitrate of magnesium $Mg\ (NO_3)_2$, nitrate of sodium (also called Chili saltpeter, $Na\ NO_3$), and nitrate of potassium (also called saltpeter, or niter, KNO_3). These are seldom present in greater quantities than 3 grains per gallon; more frequently the quantity is less than 1 grain. All nitrates are easily soluble in water. They often are formed by neutralizing nitric acid with an oxid or carbonate, and nearly all nitrates may be formed by dissolving the metal in nitric acid.

The nitrates of calcium and magnesium occur so seldom and in so small quantities in boiler waters that they may generally be considered of little consequence. Owing to their great solubility, they cause, directly, but little scale or corrosion.

The nitrates of sodium and potassium are even more soluble, and,

in this country, it is but rarely that we find them producing injurious effects. In large quantities, their action on the plates of a boiler is very corrosive, particularly when a nitrite is also present, as, by continued boiling, nitrous acid is given off, and caustic soda formed, rapidly attacking the fittings.

Silica is sometimes found in solution in boiling waters, though in very small quantities, seldom reaching 1 grain per gallon. Quartz and flint are well known forms of silica, and most of the sands are composed of it. It is practically insoluble by itself, but the presence of soda or potash in the water (especially if the water is hot) causes it to dissolve in small quantities. Ordinarily, on account of the small amount held in solution, it is deposited only in small grains in the other scale, but, where present in any considerable quantity, or where, from long use of the boiler without cleaning, it forms any appreciable percentage of the scale, it makes it hard, resisting, and troublesome.

In some of our western States, in certain localities, the only available waters for boiler use are found to contain strong solutions of alkalies and borax. The action that follows their use in boilers is so destructive that it is advisable to condense all the available steam in surface condensers, and thus use this water over and over again. In such localities the use of evaporators is strongly to be commended.

Some of this troublesome water will yield to chemical treatment, and, in case no other water is available, it will generally pay the user well to seek the advice of an expert, who may be able to reduce the resulting troubles very materially.

A comparison of analyses, showing the salts dissolved in various waters, is the best method of studying their relative values for boiler use. For this purpose I select three analyses made by Vivian B. Lewes, each of which represents an average of the waters of its class. They give the salts found in springs, rivers, and sea-waters, in grains per gallon.

	Spring.	River.	Sea.
Carbonate of calcium	13.53	8.96	2.76
Carbonate of magnesium	1.11	1.04	trace.
Sulphate of calcium	4.46	2.49	77.36
Sulphate of magnesium	0.77	0.00	120.03
Chlorid of sodium	2.19	1.49	1536.11
Chlorid of magnesium	0.56	3.49	183.06
Silica, alumina, &c.	0.19	0.22	trace.

Of all salts found in sea-waters none give greater trouble in boilers than the sulphate of lime. It is much more soluble in a saline solution, such as sea-water, than in fresh water, but, when such a solution is concentrated, or when its temperature and pressure are raised, its solubility decreases very rapidly.

As has been stated, this salt becomes totally insoluble between the temperatures 248° and 302° F., either in salt or fresh waters.

Owing to this unfortunate fact, sea-water should never be used in modern high-pressure boilers, as, with steam at 55 pounds' gage pressure, the temperature of the water in the boiler is 302°, and of course this is increased as the pressure rises. It is plain, then, that the sulphate of lime will be precipitated as soon as it enters the boiler.

It may be well to give at this point two analyses of scale formed from sea-water, made by Prof. Lewes.

	No. 1.	No. 2.
Carbonate of lime	nil.	0.97
Carbonate of copper	1.11	nil.
Sulphate of lime	90.84	85.53
Chlorid of sodium	1.41	2.79
Hydrate of magnesium	0.75	3.39
Silica	0.85	1.10
Oxids of iron and alumina	0.24	0.32
Organic matter	2.96	nil.
Moisture	1.84	5.90
	100.00	100.00

Prof. Lewes has (in his "Service Chemistry") considered the effect of concentration of the saline solution of sea-water as follows: "If ordinary sea-water be concentrated, three distinct stages of decomposition may be traced:

"(1) Deposition of basic carbonate of magnesium.

"(2) Deposition of carbonate of calcium with remaining traces of the basic carbonate and hydrate of magnesium; and, finally,

"(3) Deposition of sulphate of calcium.

"Whilst the variation in the saline constituents of the remaining liquid may be seen from the following table:

SALINE CONSTITUENTS PER CENT.

Density	1.029	1.05	1.09	1.225
Chlorid of sodium	2.6521	4.4201	7.9563	23.8689
Sulphate of lime	0.1305	0.2175	0.3915	none
Carbonate of lime	0.0103	0.0171	none	none
Carbonate of magnesium	0.0065	0.0032	none	none
Chlorid of magnesium	0.2320	0.3865	0.6960	2.0880
Sulphate of magnesium	0.1890	0.3150	0.5670	17.0100
Water	96.7796	94.6406	90.3882	57.0331
	100.0000	100.0000	100.0000	100.0000

"If the sea-water be heated and concentrated above a density of 1.225, the salt commences to crystallize out."

Sulphate of calcium, although more soluble in a dilute solution of salt than in fresh water, yet "reaches its maximum solubility at a

density of 1.033, and, after this point, concentration of the saline solution diminishes the amount which can be held in solution, and the sulphate of calcium is perfectly insoluble in a saturated brine."

The treatment of sea-water by chemical methods is not at all practical. The great space required by purifying apparatus and the large amounts of caustic soda and carbonate of soda required would make it too expensive and inconvenient a process, and, even after treatment, thorough boiling would be necessary.

As the use of untreated sea-water is unquestionably bad in high-pressure boilers, we must resort to the use of surface condensers and the evaporator, to supplement the unavoidable waste of steam. Chemicals may often be used to assist in the work done in the evaporator. Many engineers, finding that deposits of oil in boilers are far less liable to occur in water having a density greater than that of fresh water, are inclined to use sea-water in connection with water from the condensers and evaporators. This is not good practice.

Brackish water, although not as bad for boiler use as sea-water, gives a great deal of trouble, and for similar reasons; therefore it should not be used in boilers. The character of its deposits may best be shown comparatively, by the following analyses by Prof. Lewes:

	River.	Brackish.	Sea.
Carbonate of calcium	75.85	43.65	0.97
Sulphate of calcium	3.68	34.78	85.53
Hydrate of magnesium	2.56	4.34	3.39
Chlorid of sodium	0.45	0.56	2.79
Silica	7.66	7.52	1.10
Oxids of iron and alumina	2.96	3.44	0.32
Organic matter	3.64	1.55	trace
Moisture	3.20	4.16	5.90
	100.00	100.00	100.00

It is dangerous to feed a boiler with one of these waters after the other. This generally produces violent foaming, or else the sudden breaking-up of one kind of scale previous to the formation of another.

This broken scale often falls in comparatively large pieces on the sheet immediately over the fire and causes overheating; sometimes it falls between tubes, interfering seriously with the circulating currents. This action nearly always occurs when pure water from the condenser is fed into a boiler previously containing scale, and is termed among engineers "rotting out scale."

Brackish waters are often found a number of miles back from the mouth of a river, and may then yield readily to treatment with chemicals, but in such cases all the water needed should be obtained during the ebb tide.

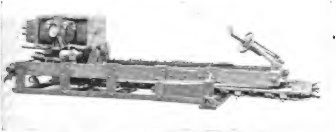
THE GROWING EFFICIENCY OF MODERN MINING MACHINERY.

By Cyrus Robinson.

THE amount of coal produced in the United States in 1895 was 193,117,530 tons, valued at $197,799,043. Of this 57,-999,337 tons were Pennsylvania anthracite, valued at $82,-019,272. This shows a production of bituminous coal of 135,118,-193 tons, with a value of $115,779,771 on the cars at the mines.

About 15,000,000 tons of this bituminous coal was undercut, or mined by machinery, the mining, on a conservative estimate, costing the coal companies ten cents per ton less than that of the coal mined by hand,—a net saving of $1,500,000.

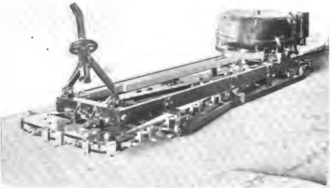
From these figures we may safely conclude that mining machines not only are established, but are an excellent investment. Many manufacturers of mining machinery advertise that a saving of from eighteen to twenty cents per ton can be effected by mining coal with their machines. This statement is incorrect, because incomplete, as can be readily shown. Pittsburg is undoubtedly the largest bituminous-coal center in the country, and, for illustration, the rates and prices obtaining there will serve our purpose. The mining rates agreed upon some time ago between the coal operators and miners were as follows; for pick mining, hand, 75 cents per ton, for which sum the miner undercuts the coal, drills and shoots it, and loads it into the mine car at the face, ready for the driver to take away to the tipple; where machines are used, 38 cents per ton is paid for drilling, shooting, and loading, 15 cents per ton for undermining the coal with the pick type of machine, and 9½ cents when the undercutting is done with the "breast" machine. Therefore we have a cost of 53 cents per ton for loaded pick-machine coal, or an apparent saving of 22 cents per ton, while, with the breast type of machine, the apparent saving is 27½ cents per ton. If this saving could be realized by substituting machinery for hand labor, we should expect to witness the closing of mines that cannot afford to put in machinery; but, as fifty per cent. of the apparent saving is practically consumed in operating expenses, and as thirty-five per cent. of the balance must be credited to interest and depreciation, the net saving is reduced nearly to 10 cents per ton, which in itself makes a good return on the investment. Therefore every coal operator would introduce power mining machinery, were it not for the fact that in many mines adverse conditions are encountered with which no machinery yet invented can cope.



"BREAST" MACHINE WITH DIRECT-CURRENT MOTOR.

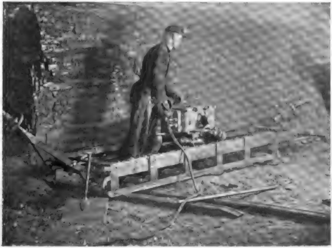
While, under specially favorable conditions, no other type of coal-cutting machine that has been built up to the present time can compete with the "breast" machine, it must be acknowledged that the pick machine—or "iron man," as it is sometimes called—is suited to a much larger number of mines and greater variety of conditions. To offset this advantage, there are a number of features that at present militate against the extensive use of this type of machine, such as a smaller saving in the cost of mining, the necessity of powerful and skilled men to operate the machines, and the fact that, up to the present time, no really satisfactory machine of this class operated by an electric motor has been placed on the market.

At this point it is well to touch briefly on the subject of power



"BREAST" MACHINE WITH THREE-PHASE INDUCTION MOTOR.

transmission in mines. This branch has been very fairly and thoroughly covered in the series of papers written by Mr. Rankin Kennedy, reviewed in the December (1896) issue of THE ENGINEERING MAGAZINE, and, in the writer's opinion, the principles laid down, although peculiar to English operations, may serve as a guide for general equipments in this country. Mr. Kennedy's paper agrees with one presented by me at the joint meeting of the Western Pennsylvania Central Mining Institute and the Ohio Institute of Mining Engineers, held at Pittsburg in June, 1896, in concluding that the electrical system is superior, as a whole, to any other system of transmitting power. Affording as it does a maximum of flexibility and simplicity, and rendering it possible to use successfully one generating plant for furnishing power to all parts of the mines and for all purposes, such as coal cutting, drilling, lighting, pumping, hoisting, haulage, fans, screens, conveyors, etc., the advantages of such a system, with its consequent reduction in the cost of operating the plant, must be apparent at once to the mind of any business man. That this is the case is shown by the large number of mines in this country operated throughout by electrical machinery.



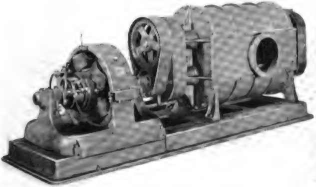
"BREAST" MACHINE IN OPERATION.

As in other branches of the electrical industry, a great deal more work has been done in this country than abroad in the application of electricity to mine work. Although I have not the statistics at

hand, I may state with approximate accuracy that, out of the 212,000,000 tons of coal mined in Great Britain in 1895, not more than 750,000 tons were mined by machinery. Probably it would surprise Mr. Kennedy to learn that during the past year over $1,000,000 worth of electrical machinery has been installed in coal mines alone in the United States, and that fully ninety per cent. of this was for coal cutting, and at least $400,000 worth of compressed-air machinery has been furnished for coal cutting, and the coming year promises to see still a larger business. Among the reasons for this is the fact that for some years past the mining of bituminous coal in the United States has not, as a whole, been a lucrative business. Carefully-prepared statistics of the coal industry of 1895 show that, on an actually invested capital of $320,000,000, not more than 3½ per cent. was cleared, and it is not surprising to note the active interest being taken in methods and machinery that will increase the returns on the enormous investment. Unfortunately for a number of coal operators, particularly the smaller ones, the conditions in their mines practically prohibit the successful use of such machinery as is at present on the market, and the introduction of machinery by their more fortunate competitors can naturally be followed by one result only,—the wiping out of the small profit that they are at present obtaining,—unless some one in the meantime come to their rescue with a machine that will cope successfully with the conditions.

In this paper prominence is given to the mining machine, or coal cutter, as it is the agent which, if properly used, effects the greatest single saving. Other electrical machinery, though effective in reducing the expense, is by no means as effective as this. In the majority of mines it would not pay to install an electrical plant for haulage alone. The apparent saving might, in some cases, reach three or four cents per ton, but, as the depreciation which has to be written off every year in mining plants is great, this saving is generally offset.

It is unfortunate that the consulting engineer is not used more by coal companies considering the installation of a plant, to technically advise as to the purchase. As a rule, the officers of a mining company are not mechanical or electrical experts, and have only a general knowledge of the appliances on the market. At present the engineering work for these plants is done by the representatives of the various manufacturing companies, and, as each is desirous of securing the order, there is a great temptation to recommend a plant made up of the smallest possible units for the work. This is particularly noticeable in regard to the conductors or pipes for transmitting the power. The writer frequently has been astonished to find his competitor for a plant proposing a conductor of about one half the carrying-capacity re-

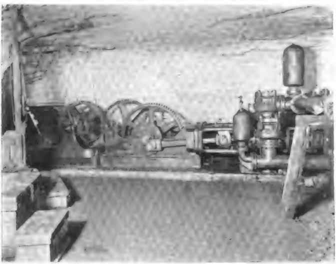


ROOT BLOWER DRIVEN BY SLOW-SPEED MOTOR.

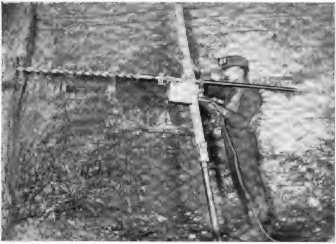
quired, stating to the coal company that it was very foolish on the part of anyone to aim at high efficiency in a coal-mining power-transmission plant, as coal was cheap at a coal mine. It is not the coal alone in this case that should be considered, but the increase in the size of the generating plant made necessary by the proposed excessive loss of power in transmission. In my experience, the average dealer in this class of machinery never thinks of compensating for the great loss in the line by increasing the size of the generating plant; consequently he is able to offer a cheaper all-round plant, and, if he gives a strong enough guarantee, he oftentimes succeeds in capturing the contract. When the plant is installed, it starts under a strain, and in many cases fails to do the work guaranteed; delays, bad feeling, and generally a compromise result, the purchaser having probably lost twice as much by the delay as the services of a competent engineer would have cost him, besides not having a plant adequate for his present requirements, let alone the future. These troubles are noised abroad, and the blame is placed, not in the correct quarter, but on mining machinery in general, consequently rendering it almost impossible to secure another order in the district for some time—generally not until the plant in question has been rebuilt in many respects. When it is considered that the average mining plant, for a mine producing one thousand tons of screened coal per day of ten hours, costs approximately $20,000, this figure covering coal cutting, haulage, and drilling, it seems that the purchaser, for his own protec-

tion, ought to secure the services of a competent engineer first to determine the requirements from the conditions in the mine, and later to superintend the installation of the plant.

A few facts concerning the machinery illustrated in this paper are of interest. Two of the coal-mining machines illustrated are of the type known as breast machine; the third as the pick machine, or "iron man." Another cut shows the breast machine at work in a room in the mine, and very clearly illustrates the method of operation. An average day's work of ten hours, for a machine of this type, is one hundred feet, lineal face, under cut from five to six feet; this average cannot be obtained, except with clean coal, even and regular horizontal formation of the vein, and, above all, good roof. This last condition is essential to the successful working of the breast machine, as will be readily observed from the illustration of the machine at work. If the nature of the roof is such that the timbers, or props, must be placed close to the face, the efficiency of the machine will be greatly reduced, and, in many mines, where the roof is very faulty, they cannot be used at all; so that it becomes necessary to resort to the pick machine, which, being much lighter and of a purely portable construction, enables the miner to work between and around the posts, in about the same manner that he would with a hand-pick. With the

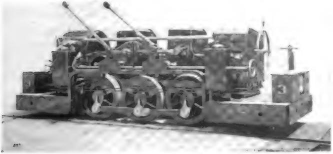


ELECTRICALLY-DRIVEN DEEP-MINE PUMP.



ELECTRIC COAL DRILL IN OPERATION.

pick machine an average man will undercut from 60 to 75 lineal feet face of coal from 3½ to 5 feet under, per day of ten hours. He will, however, in doing this, make from three to four times as much fine coal as the breast machine, due to the difference in the shape of the cut, it being necessary for the pick machine to make a wedge-shaped mining, tapering from a height of twelve to sixteen inches at the front, or face, to a height of about ten inches at the back of the cut.



BALDWIN ELECTRIC MINE LOCOMOTIVE.

JEFFREY ELECTRIC MINE LOCOMOTIVE.

GENERAL ELECTRIC MINE LOCOMOTIVE.

Peculiar as it may seem, the breaking up of so much coal by the pick machine is a decided advantage to the coal company in districts where the mining rates are based on screened coal, as the coal cuttings going through the screens represent a clear gain of mined fine coal to the company. The coal miner, however, is partly compensated by the increased price paid for mining with this type of machine.

The coal drill illustrated, which was designed by the writer, has come into extensive use in connection with the mining machines of both types, particularly in Ohio, Illinois, and West Virginia. One of these machines in the hands of a man and boy will drill a sufficient number of holes to shoot down 600 tons of six-feet coal per day of ten hours; and, as the saving is about one cent per ton, the purchase of a drill makes a very excellent investment. Even in mines where the coal is very soft, such as the Pocahontas, this saving can be realized, and the system of having all the coal drilled by one man results in a much better grade of coal, as the driller becomes expert in placing the holes to best advantage for shooting the coal with the least amount of powder.

I have chosen three types of electric mine locomotives as illustrating the present practice. The first two shown were designed by me for the Jeffrey Manufacturing Company and the General Electric Company, and the other is the product of the Baldwin Locomotive Works. The Jeffrey and the General Electric locomotives, although much alike, have distinct differences in the arrangement of the parts. The General has the operating platform on one end, while the Jeffrey has it in the center; the former has the advantage of placing the motorman within easy reach of the coupling-pin, when going in one direction, and, if the switches are properly arranged, the efficiency of the locomotive is materially increased; while the latter gains in having the man better protected in case of a collision or runaway, and in a more even distribution of weight on the drivers, as well as a shorter machine. This latter feature is a very decided advantage in mines where the curves are of short radii and the entries narrow.

Both locomotives are equipped in other respects in about the same manner as an ordinary electric street-car truck, having one motor on each axle, with single reduction spur gearing. This construction has both advantages and disadvantages; among the former may be included simplicity, low first cost, small number and interchangeability of parts, and chilled cast-iron drivers; among the latter is inability to obtain the same tractive power from both axles, it being practically impossible for two electric series motors to divide a load equally between them, connected as they necessarily are on a machine of this

type. This trouble is largely overcome in the Baldwin locomotive by coupling the drivers, but, in securing this advantage, the excellent features of the first type are lost. Mining camps are the last places in the world in which to install complicated machinery, if it can be avoided, and, in designing machines for mine service, it is necessary to sacrifice many features otherwise highly desirable, in order to obtain simplicity. One of the principal reasons causing me to adopt the construction that obviates the necessity of coupling the drivers was the great difficulty in getting the drivers turned down at the mine when it became necessary. Besides lack of proper facilities, there is another serious trouble, common to all locomotives operated with an overhead trolley and track return,—namely, the sparking between the rail and the face of the drivers, which has the effect of hardening the faces of the wheels, so that, after a few weeks of service, they become so hard that it is practically impossible to turn them with a tool, making it necessary to grind them down,—an expensive and very troublesome operation. Another reason was that at the majority of mines there are but poor facilities for lifting quickly the heavy weights that have to be handled, whenever the drivers are replaced. A locomotive so constructed that this is not necessary has a decided advantage.

To determine the size of locomotive required, the only safe way is to make a number of tests, with a dynamometer, of the drawbar-pull required to haul the cars in the mine where the locomotive is to be used, there being so wide a difference in the track and car construction in different mines that, in the writer's experience, he has never found it safe to more than approximate the size required before making the test. He has found the required drawbar-pull to vary all the way from twenty pounds per ton to fifty and, in extreme cases, as much as seventy-five. The rules laid down for surface railroad practice will not apply in mine service. On the average surface road there is a comparatively clean rail, while in a mine the rails generally have a coating of moist coal dust, which is an excellent lubricant, so that in mine practice it has been found necessary to use a factor of eight for determining the weight required on the drivers from the drawbar-pull, instead of five, which has been found sufficient for surface work. Some of the worst failures in electric mine haulage have been caused by neglecting to have sufficient weight on the drivers.

Other illustrations accompanying this paper—of pumps, hoists, and blowers—serve to show the great variety of uses to which electric motors are put, in and about a mining operation.

STREET-CLEANING IN PARIS AND BERLIN.

By Robert Grimshaw.

IT was remarked at a recent public meeting in New York that the citizens, having once tasted the advantages and conveniences of clean and unobstructed streets, would never consent to a return to the old order of things, where filth and all manner of obstructions were allowed to encumber the public ways. For years the one unpleasant feature of the American's return from abroad was the sudden contrast offered by the streets of his native cities to those which he had just left on the continent. So the same feeling that New Yorkers are beginning to cultivate, in taking it as a matter of course that the streets should be kept clean, has become an ingrained public sentiment in the cities of Europe, and especially is this the case in Paris and Berlin, the method of the cleaning of whose streets should be of moment to all who are interested in municipal affairs.

Here are two cities, one with a population of 1,800,000 and the other with a population of 3,000,000, where the two things that make the first and strongest impression upon the visitor are the immense street traffic and the extreme cleanliness of the road surfaces. The blinding dust that we have regarded as an unavoidable nuisance is unknown in Paris, despite the fact that its streets are so constantly crowded with surging humanity and the horses and vehicles necessary to administer to its business and pleasure. Yet so efficiently and unobtrusively is the cleaning of the Paris streets accomplished that one forgets the existence of the corps of workers, and comes to look upon the city as resembling those homes that are always in order.

The work of maintaining this order and cleanliness of the streets was formerly under the control of the prefect of police, but in 1859 it was transferred to the prefecture of the Seine and placed in charge of the engineers of public streets,—a change of great importance when regarded from a financial standpoint, inasmuch as it lowered the annual expenses from $885,510 to $734,944, the latter being the figure in 1872. These expenses have risen since, however, reaching $1,250,290 in 1889.

The street-cleaning department may be said to work with four subdivisions: the first has to do with the purchasing and maintenance of materials; the second, with the employees; the third, with sprinkling; the fourth, with the removal of offal and rubbish.

Of the first little need be said. Its function is to buy tools and distribute them to the several sections, and, when anything is in

need of repairs, to replace it at once by a duplicate in good condition. At the present time the annual outlay of this division amounts to something more than $65,000.

It is with the second division that the public interest in the work begins, and, if we wish to watch it from the first stroke done in the day, we must be up betimes, for the work starts, year in and year out, at 4 A.M.

The first sweeping and scrubbing of the morning is done at the expense of the owners or tenants of the adjacent properties at the rate of about six cents per square yard, while the day cleaning is paid for by the city. The whole area cleaned amounts to 18,674,400 square yards, and the total tax is about $660,000

Both men and women are employed in the street-cleaning corps, which is divided into 149 brigades. In the heart of the city one of these brigades usually consists of a chief, one assistant, and twenty-five laborers who may be men or women. Of these the major portion work only in the morning. During the second half of the day "cantonniers" are employed, whose duty it is to clean the streets, urinals, police stations, markets, and cab-stands. In the outlying sections each brigade consists of a chief, four cantonniers, and from fifteen to twenty sweepers, the latter being employed in the afternoon only, except in bad weather. The pay of these employees, of whom there are about 3,200, varies with their efficiency, and is placed at the following rates per hour:

Strong men....................	6½ to 7½ cents.
Old "	6 cents.
Women........................	5½ cents.
Children......................	5 cents.

A chief of the first rank of cantonniers receives about $25 per month, and the rank and file about $21, out of which each pays $1 into the savings bank, which is repaid with interest when he leaves the service. All employees are also compelled to maintain a specified accident insurance.

In the performance of the actual labor both the hand-broom and the sweeping-machine are in use. The latter finds its especial application upon stone-paved streets and in times of snow-fall, while the former is in use upon the asphalt and wooden paving.

The sweeping machines are heavy and of two kinds,—the Sohy and the Blot. The former has a cylindrical brush 75 inches long, and sweeps a strip 72 inches wide on the first trip, after which the parallel strips run from 48 inches to 64 inches in width. Thus, at a rate of travel of about 240 feet per minute, each machine will sweep 7,200 square yards hourly. The Blot machine has a shorter brush, not so

obliquely placed, so that it does not throw the material out as well as its rival, though the ground covered is practically the same. It is drawn by one horse.

It is on the asphalt streets that the great interest centers, on account of the thoroughness with which the work is done. The hand-brooms are of the "piassava," a tough South American palm fibre, whose botanical name is *Attalia funifera*. These brooms are about 16 inches long and 4 inches wide, and are built up of five rows of from fifteen to eighteen meshes, each 8 inches long. In addition to the brooms, the laborer has a rubber squeegee 32 inches long. In the early morning the hydrants are opened, and the asphalt is flooded,—flooded not merely by allowing the water to fill the gutters, but by throwing water from large wooden scoops over the whole surface of the street, until everything is loosened and ready to flow. Then the brooms and squeegees are brought into action, and the whole surface brought to a condition of almost absolute cleanliness. This is the main cleaning of the day, after which the work is light. Sprinkling or wetting down is always done by hose, watering-carts, scoops, or pots before the sweeping; in rainy weather the sweeping-machines may be used, and these are always followed by the hand-broom to bring the rows of refuse into heaps for loading into carts. Of course, in freezing weather the washing is omitted; then the work is done by a sweeping-machine in the afternoon. Gutter-cleaning follows each sweeping; the gutters are usually washed twice each day.

For the past few years the street-sprinkling has been done, in the main thoroughfares, by the cantonniers with a hose. Still, the watering-cart is extensively used, and there are 370 in service, drawn by horses, beside a number propelled by hand. The carts are the property of the city, a contractor furnishing the horse and driver at $68 per month. The sprinkling period begins between March 15 and April 15, and extends to the middle of September or October, according to the season and the kind of pavement, the total sprinkled area being 6,556,800 square yards.

As I have said, work begins at 4 A. M., and between that and 6:30 the sidewalks and streets are cleaned and sprinkled, sand is strewn on the asphalt, and the cab-stands are washed and disinfected. Then the sweepings are taken away, and cleaning resumed. Between 8:30 and 11 the streets are sprinkled with hose or watering-pot and re-cleaned, the public urinals are cleaned, and then comes the rest for breakfast, lasting till 1 o'clock. From 1 to 4 there are machine-sweeping, squeegeeing, and hand work; at 4 the work is ended, unless the weather requires overtime—to 5, 6, or even 7 o'clock.

The removal of the sweepings, which is quite as much of a task as

the sweeping itself, takes place, in summer, between 6:30 and 8:30 in the morning; in winter, between 7 and 9. About an hour before the arrival of the wagons, householders are obliged to deposit their refuse material in strong receptacles placed in the corridors, and these must be kept clean and in good condition, and must not exceed a specified weight. The removal of the sweepings costs about $400,000 per year.

The removal of street and house sweepings, fallen leaves, and vegetable and animal refuse from the markets is done by contract, not including, however, the removal of decayed vegetable and animal matter, dead animals, and offal and excrement, from the slaughter-houses. The contractor is at liberty to choose his own dumping-ground, subject, of course, to approval by the city authorities. The material is the property of the contractor, and what he cannot utilize he ships to a point about ten miles out of the city. Attempts to utilize as manure such animal matter as the intestines of chickens and rabbits, spoiled fish, etc., have not proved successful. The cost of removing this refuse can only be approximated, and is placed at from 57 to 63 cents per day per thousand inhabitants.

Many experiments have been made in disposition of fæcal matter. It has been used for agricultural purposes, and it has been cremated. To carry it away in boats involves the difficulties of low water in summer and ice-blockades in winter; for rail transportation the regulations are so strict and the freight charges are so high that seventy-five miles becomes a prohibitive distance, rendering its utilization in the barren places of Tarifen, Champagne, or Sologne impossible.

Cremation is expensive, as the English have shown, since the mere erection of the suitable plants in Paris would cost at least $1,200,000, and even then some provision would have to be made for the removal of the ashes; the carting could go on for only two hours a day, while the kilns would have to be kept red-hot continuously.

Paris is not often visited with a heavy snow-storm, and up to the winter of 1880 the snow was removed from sidewalks and courtyards by the householders, while the administration managed to get rid of the snow by means of carts obtained from the omnibus company, the garbage contractors, and other sources of supply. But a heavy fall of snow in 1879 brought out an ordinance that went into effect in October, 1880, under which every able-bodied laborer can, at the beginning of the winter, register himself as a snow-cleaner, whereupon he will be assigned to some specified place at which he is to report at every snow-fall.

The streets are classified according to the urgency existing for the removal of the snow. First, the wide streets, in which the snow is heaped into rows, with a clear space of from 16 to 24 feet in the mid-

dle. These piles, as the weather permits, are removed, made into one, or strewn over the roadway. Second, the narrow streets with a heavy traffic, where the snow must be entirely removed. Third, streets where the snow can be thrown into a single row, and allowed to remain until a thaw.

The best machine for snow-cleaning has been found to be the rotary sweeper, having a row of steel "bristles" between each two rows of piassava. Snow-ploughs have been used, but, though drawn by four horses and manned by two men, they have not fulfilled the expectations of the authorities. They are too heavy, and cannot be used in the heavy-traffic streets. Still, there are eighty-eight of them in use.

Salt was first used in 1880, and is said to give no trouble. One man takes it from the wagon, and it is spread about by means of a funnel in the hands of another. There are also some salt-strewing machines, but they have shown no advantages over hand-work. For a snow-fall of two inches about half an ounce of salt is required per square yard. The quality used is the coarse eastern, which costs about six dollars per gross ton.

The snow that is carted away from the ten wards bordering the Seine is dumped into that river, where there are forty-two dumping-places. Those wards which do not lie along the river use the gutters and sewers for snow-dumping, both hot and cold water being used to assist in rapidly carrying it away. As the removal of snow, even by the means described, would occupy too much time, a portion of the work is done by private contractors, the streets being divided into twenty-eight contract districts, each having a dumping-place in the Seine, the sewers, or elsewhere. So, when a specially heavy fall of snow occurs, all available municipal means are employed, and the contractors are set at work, their pay being based on the number of cubic yards removed, with results highly satisfactory.

The omnibus company is pledged to set fifty carts at work, and to haul something more than five thousand yards of sand to various parts of the city.

When the snow falls during the day, the cantonniers and extra laborers commence the cleaning of the city's sidewalks and roadways; the householders do the same before their houses; and every effort is brought to bear on those streets needing immediate attention. If it comes down at night, the snow ploughs first clear a space of 16 feet or 20 feet in width, and are followed by the sweeping-machines. When these are insufficient to remove the trodden snow, sand or salt is used, giving a partial relief to the traffic, after which the removal of the snow begins, and is pushed as rapidly as possible. When the greater portion of this work has been done, the streets of the second class are under-

taken, and then the third, unless a thaw has set in to render it unnecessary, in which case transportation is stopped, the hydrants are opened, and the snow is swept into the gutters by machines.

As for the total expenses of the Paris department, the latest figures available are those for 1891, when they amounted to about $660,000,—figures that are interesting from the fact that they represent work thoroughly, promptly, and constantly done, under all conditions of temperature and weather. No excuses are offered, and none will be accepted, for work imperfectly or intermittently performed. The merchants recognize the fact that clean streets represent profit, and dirty ones loss, and they would rebel in a week if the work of street-cleaning was in the least slighted.

Turning to Berlin, we have a city of about the same population as Chicago, but with what a difference in the appearance of the streets! In one cleanliness is assumed as the normal and only permissible condition; in the other—well, perhaps the less said the better.

In Berlin the work of cleaning the streets is done "direct" by the municipal government acting through a department, created nearly twenty years ago, that has charge of the cleaning of streets and squares, the removal of sweepings and other refuse as well as snow, and the sprinkling and maintenance of streets, public urinals, and closets. The area under its care amounts to about 8,000,000 square yards, of which about 35 per cent. is paved with stone and 15 per cent with asphalt. The personnel of the force consists of a director at a salary of $2,500 per year, 6 inspectors, 1 depot master, 22 district inspectors, 84 foremen, 450 first-class workmen, 70 second-class workmen, 90 helpers, and 28 stone-breakers, besides a tailor and carpenter, making 722 employees in all. The inspectors and depot-master receive from $600 to $700 a year, the laborers from 40 to 80 cents a day, and the foremen 94 cents. The laborers are supplied with uniforms free of charge, and in almost every instance the department pays half of their insurance against illness; they are not obliged to furnish their own tools, as most other laborers are, and are paid for Sundays and holidays. When they grow unfit for work, they receive a yearly pension based upon their length of service, ranging from $100 to $150.

The area to be cleaned is divided into six districts, and the work, without exception, is done by machines, of which there are forty-two. The manning, hauling, and maintenance of the machines are let to a contractor, who receives $1.50 per machine per working day. In addition to the forty-two regular machines, the contractor has nine extra machines, held in reserve for emergencies. The duty demanded of the machines is not stipulated, as it depends upon circumstances,

but it may be taken to range from 6,600 to 10,500 square yards per hour. The reason given for the use of the machines is that they do the work more economically than it can be done by hand.

The removal of the sweepings is also let to a contractor on a six-year agreement, at about $94,540 per year, which does not include the removal of snow. This latter is paid for by the load, but from the amount is deducted that which would be paid for the removal of the sweepings during the same length of time. The prices paid are 54 and 60 cents per load.

The carting of the street manure and sweepings, as well as the snow, is at the contractor's expense, and he provides his own dumping ground, being free to utilize or dispose of the materials. Removal of snow by melting has been unsuccessfully tried. The utilization of the street manure and sweepings is not as complete as might be desired; still, more than half is shipped by water from Berlin, and the contractor is supposed to realize a profit of about 25 cents a load.

It is well known that asphalt paving is more easily cleaned than any other, but it demands special treatment, because it is smoother and requires constant and uninterrupted attention in order to prevent accidents to horses and vehicles. Horse manure is especially dangerous, so that particular care has been directed to its prompt removal, thus reducing complaints to a minimum.

As Berlin has a larger percentage of asphalt paving than any other great city, especial attention has been paid, in considering street-cleaning there, to the best method of work with this type of road surface. In general, all streets regularly cleaned are sprinkled twice a day, but those that are particularly dirty are sprinkled three or even four times daily. An exception is made, however, in the case of the asphalt streets; these are not merely sprinkled, but regularly washed, every day, the pavement being first liberally sprinkled to soften the coating of dirt and then squeegeed, which dispenses with the necessity of a second washing on the same day. In view of the great extent of the asphalt, a considerable saving is thus effected. Mere sprinkling would not answer, as the layer of dirt would only be made more slippery and unsafe for horses. The sprinkling season extends from April 1 to October 1, costs about $56,000 a year, and uses about 215,000,000 gallons of water.

As I have said, the sweeping is done exclusively by machines with piassava brushes. These, as well as all other supplies for the department, are bought in the open market, and at an expense of about $15,000 a year, the wear and tear depending upon the season, being naturally greatest in winter. The total annual expenses of the department are about $405,000, from which must be deducted various

incidental receipts, amounting to about $31,000, leaving a total net expenditure of about $374,000.

A portion of the receipts is due to the obligation of the railroad companies to clean and sprinkle all streets in which they have their rails. Double-track streets must be cleaned for a width of 18½ feet, and single-track streets to half that width. The department, however, does this, the railway company paying three-fifths of the actual cost.

The sweeping-machines are mounted upon four wheels, with the brush between the two rear wheels and rotated from the axle. This rotation may be stopped without stopping the machine, and the brushes may also be lifted clear of the ground. The bevel wheels are protected by sheet-iron casing; the oil boxes have special dust covers; and the oil is carried to the journal bearings by wicks. The driver's seat is on springs; the lamps are hung on spiral springs. A brush lasts 225 hours, new "bristles" costing as much as a new brush.

The sprinkling-cart barrels are of sheet iron, .16 of an inch thick. They are cylindrical, and provided with two wrought-iron bands, and are carried on a wrought-iron frame. The filling is done through a full-sized man-hole, so that inspection, cleaning, and painting are easy. This man-hole is closed by a plate with a felt gasket. The cart is usually drawn by one horse, but may be fitted with a pole. The rear wheels carry the greater portion of the weight, thus facilitating the turning. The sprinkling valve is opened by a foot-lever, the tube being of wrought iron. It is easily cleaned, and the holes in it are carefully bored, so as to insure an equal distribution of the water, which is thrown over a strip about 14 feet wide. The maximum speed of hauling is about 380 feet per minute.

On all of the asphalt streets there are cast-iron receptacles for the sweepings. These are about 5 feet 10 inches high, 20 inches wide, and 14 inches deep. At the upper end they have a semi-circular sliding cover, and a door at the bottom. The contents are removed in wheel-barrows, the latter being of iron with wooden wheels and holding about 7 cubic feet.

Thus we see that, in the two greatest cities of continental Europe, the details of the practice of cleaning the streets are widely different, and yet the results obtained are practically the same,—clean streets at a reasonable expense.

Bridge Accidents in United States and Canada in 1896.

A COMPILATION of statistics of bridge accidents for the past year in the United States and Canada has been compiled by Mr. Charles F. Stowell, and presented in *Engineering News* (Feb. 11) in tabular form, with comments. The lists do not include wooden bridges burned with no accompanying casualty. Neither do they include "an extremely long list of bridges carried away by floods, or bridges blown down without other damage to person or property." The accidents are named in three schedules,—those on electric railways, those on steam railroads, and those on highways. Thirty-seven are recorded as occurring on thirty-three different steam railroads, and as causing the death of fifty-seven people, and injuries to eighty-six more. On the electric railways, six bridge accidents are recorded as occurring on five roads, killing forty-six people, and injuring nine more. The proportion of deaths to the total number of bridge accidents on electric roads is, therefore, very much greater than that in the list for steam railroads. Whether this is a mere coincidence for the year, or whether it results from some cause peculiar to electric railways, is not made clear. A curious inference drawn by the author—to wit, that July is the most dangerous month in the year wherein to cross bridges, while June is the safest—rests on no better foundation than the events of a single year; and, if the observations of a single year were enough, it is not wholly clear from an inspection of the tables how this conclusion can be legitimately derived from the facts there noted. "Of the structures involved" (on the steam railroads) "eight were wooden trestles, seven iron or steel bridges, nine wooden bridges, and thirteen of unknown construction. On the electric roads one only of the bridges was a wooden trestle, one a stone arch, and there were four iron or steel trusses." On the steam railroads the accidents are classified as "five square falls, six destroyed by fire, five by freshets . . . three unknown. In one case the bridge was a Howe truss draw-span, which gave away in consequence of the breaking of the wire-lifting cables. The worst accident was at the Cahaba bridge in Alabama, where the rails had been removed by train-wreckers, causing a derailment which resulted in the destruction of the bridge." In this accident twenty-four people were killed and eleven others injured. The number of accidents with highway bridges was fifty-nine; the number of lives lost in these accidents was fourteen, while the number of people injured was fifty.

Clay as a Modern Building Material.

THAT a sort of revolution has been going on in the brick, tile, and terra cotta industries, during the past twenty years, has been obvious to observers of progress, but the extent of the change is hardly yet appreciated, even by builders. Architects, however, realize that the increased use of iron and steel in building construction has very materially affected the use of brick, tiles, and terra cotta, and they are, perhaps, outside of the manufacturers of these articles, the only ones who have an adequate idea of the nature and extent of the changes that have been quietly going on. Formerly, when bricks were used for the weight-bearing and floor-supporting parts of large structures, they were required to have great strength and solidity. Except for fronts, beauty was a thing hardly thought of. Now, as is pointed out by Mr. Henry R. Griffen in *Brick* for February, "lightness, durability, and beauty are the primary essentials." The only quality which the modern product is required to retain out of the former requisites and in an equal degree is durability. "In former days the clay work was the building; now it is the shell, the beautifying agent, and the protector of the metal frame. To-day

as many or even more brick may be sold for building construction as in the past, but they are sold under different conditions; the old contracts for brick by the millions for single buildings are rare, but, on the contrary, the demand for hollow building material has wonderfully increased, and, in fact, has grown from nothing into an enormous business within a few years." One of the clearest indications of the increased part ornamental clay work is to play in the future is the great extension in the output of clay-working machinery. No statistics of the growth in this line of machine-manufacturing are at hand, but it is safe enough to say that the growth has been remarkable and significant. "A few years ago the manufacture of enameled and glazed brick was in its infancy in this country, and there was some doubt as to its continued existence. To-day this manufacture is carried on successfully by several concerns, and the business is firmly established." One of the problems now engaging earnest attention is the production of glazed and enameled terra cotta, for which, Mr. Griffen tells us, there is already a demand. The demand existing, all precedent warrants the belief that the desired product will be forthcoming, especially as there appears to be no insurmountable difficulties in the way. Another article of modern origin and now in demand is the thin hollow block, glazed on both sides, for partition walls. So far the demand has not been satisfactorily met, but Mr. Griffen predicts a large business in this line when a product satisfactory in quality and quantity shall have been reached. The author does not attempt to outline the effects of these changes upon the lumber and other building-material trades upon which clay products are more or less encroaching; but he foreshadows some of these effects, when he speaks of a clay product in the future of such finish that coatings of plaster or cement will no longer be needed. The perusal of Mr. Griffen's paper presents to the mind of the observer of current events an active, energetic, aggressive industry, so much removed from the character of the brick manufacture of two decades ago as to fully justify the assertion that clay working in the manufacture of building materials has been revolutionized within the period named.

Shortage of Water-Supply in Brooklyn.

A VERY suggestive article by Mr. George E. Waring, Jr., in *Harper's Weekly*, upon "The Water Famine in Brooklyn," deprecates the prevalent tendency among water-works engineers to meet an impending shortage by resort to greater reaches and more distant supplies. The chances are ten to one, in most cases, that the impending shortage is the result of needless and even wanton waste, and that the existing supply is more than double that actually needed for necessary uses. No doubt houses and flats in Brooklyn could be found which, every twenty-fours, waste four gallons for every gallon necessarily used. We are not at all sure that instances of this kind would be comparatively few, and we are certain that instances of even more exaggerated waste are not infrequent. We have known of a case where constant flow through a flush-trap out of repair was allowed to go on for over a month, the stream thus going to waste being a large fraction of the full discharge capacity. This was in a row of flat buildings, and there is not the slightest doubt that this stream alone, running night and day, discharged more water into the drain-pipes than was necessary for the actual needs of the whole row. Therefore we can subscribe without any reservation to Mr. Waring's protest against this weak yielding to a great public vice—the careless and wanton waste of water.

"Water," says Mr. Waring, "must be 'as free as air,' and the people must be allowed to use it and to waste it at their own sweet will, no matter what it costs to supply them. Every attempt to check this tendency is frowned down, often by the very men who should be the first and most zealous in regulating use and in preventing waste." What he says further with reference to the present water-supply in Brooklyn is equally applicable to a hundred cities in the United States where people are clamoring for increased supply. "The simple truth is that Brook-

lyn has, in the works on which it is now depending, water enough to last it for every possible proper use for so many years to come that there is now no need even to consider a further source of supply. The millions it is proposed to spend to get more water may be saved by a proper application of relatively insignificant thousands for the prevention of waste." The principle here enunciated may be paraphrased mathematically by saying that the cost of rendering present supply adequate for all reasonable wants is to the cost for obtaining a supply for unreasonable demand and for wanton waste as thousands to millions. Thus stated, the principle is applicable to most North American municipal water-supplies. "It has come to be the prevalent notion," adds Mr. Waring, "that no town is safe—in this country, at all events—unless it has at least one hundred gallons per day for each person of its population. It is a fact, well-known to those who have made a study of the matter, that less than one-third of this amount would suffice for the most liberal needs of any community. This opinion is fully supported by English experience." The English are a people noted for their cleanly personal habits, and would be intolerant of any restriction in the right use of water; notwithstanding this, the daily water-consumption of Liverpool was twenty-three imperial gallons per head in 1881; and Mr. Waring quotes Mr. J. Parry, the Liverpool water-works engineer, as saying: "There is probably no modern city in which the legitimate demand for water and the facilities for using it are greater than in Liverpool. Water-closets are general, and it has long been a practice to supply baths in all houses of more than ninety dollars' annual rental." A diagram showing average rate of flow for the twenty-four hours of the day proves clearly that much of the waste goes on without the knowledge of the consumer. It shows that the flow continues at hours when the needed use of water is at a minimum, and at a rate which is clearly far beyond any demand that the population is making at such hours. In fact, the evidence that in American cities generally more water is wasted than is consumed is beyond all serious question. If influential engineers generally would take the same firm stand on this question that Mr. Waring has, there might be hope of reformation. The remedy is in a good system of inspection and the use of meters which register water wasted as well as that used. These means have time and again converted want into plenty, without any enlargement of supply.

Thermal and Mechanical Cut-Outs.

ONE of the commonest of electrical devices is the fuse; yet Prof. W. M. Stine, in a paper read before the Northwestern Electrical Association at Milwaukee January 21 (reported in *Western Electrician*, Feb. 20), says that some thought and study may yet be profitably devoted to it. He will hardly be contradicted in the statement that "the rational way of regarding a fuse in circuit, and of obtaining a just estimate of its protective value," is to consider each element of the circuit as a thermal cut-out to a certain extent, capable of fusion by the heat of the current provided this be pushed beyond the heat-resisting power of the element, and the fuse as a metallic element purposely introduced into the general circuit, and so related to all the other parts as to make it, as regards its heat-resisting power, the weakest part of the entire circuit, "its weakness being so adjusted that it shall yield before the other circuit elements are harmed." The final consideration in the proper adjustment of a fuse in a circuit must be given to that element of the circuit which, without the fuse, is the weakest. The fuse must be weaker than that weakest part, yet not so weak as to incommode by its too ready fusion. "Beginning with the generator, its armature has a known carrying-capacity, and one which does not admit of a great margin. This is also true of the motor armature. In the leads the need for thermal protection is slight; in branch and tap circuits it assumes a grave importance, increased by the uncertainty of joints and local corrosion. The transformer, again, offers much the same problem as the generator and motor." Mr. Stine notes

that, although so extensive and common use of the fuse wire was made, its "vagaries and uncertainties," up to a recent date, "became almost a by-word." . . The manufacturer of fuse blocks, beyond a change of material,—wood to porcelain,—had shown no satisfactory progress. The fuse wire had been investigated in a few laboratories, but in rather a casual and incomplete manner, and the results were confusing rather than instructive. In view of this unsatisfactory state of knowledge upon the subject, Prof. Stine commenced a series of tests about two years ago, the object being to obtain data and formulate "precise directions for the use and rating of fuse wires." Several thousand determinations were made, the principal points investigated being "the time element and uniformity of fusing, the carrying-capacity as influenced by length, diameter, and enclosure, the effect of use, and the influence of the receptacle." As the value of the time element may not be at once apparent, the author occupies a little space in its consideration. Uniformity of the fusing-point, also of great importance, is considered at some length. This part of the discussion is summed up in the following conclusions. (*a*) "Covered fuses are more sensitive, and have a lower carrying-capacity, than exposed ones." (*b*) "Fuse wire should be rated for its varying capacity for the lengths ordinarily employed." (*c*) "Fuse blocks should be made with greater distances between the terminals." (*d*) "Fuses should be removed from time to time, as they become coated or fouled." (*e*) "The time element should be considered when protecting parts which are liable to burn out." (*f*) "Fuses up to five amperes should be at least 1½ inches in length; one-half an inch should be added to the length for each increment of five amperes." (*g*) "Except for smaller sizes, flat fuses are more reliable than round wires." (*h*) "Round fuse-wire should not be applied in excess of thirty amperes' capacity. For higher currents flat ribbons exceeding four inches in length should be employed." The ordinary manner of making fuse wire is criticised as entirely inadequate. "Each spool of wire should be accompanied by a curve, or table, clearly setting forth the carrying-capacity for varying lengths." Prof. Stine goes still further, and recommends the discontinuance of the use of fuse wire, and the substitution therefor of "fuses already mounted to copper terminals, and plainly marked with their normal rating, which should be at 80 or 90 per cent. of their fusing currents." As compared with the action of mechanical cut-outs, the action of the fuse is extremely slow. The choice between these devices must, of course, depend more or less upon the conditions of service. For protecting motors, except in the smaller sizes, circuit breakers are preferable, fuses not being reliable. Simplicity should characterize all mechanical cut-outs. "The electro-magnet should contain but little iron, and the mechanism for opening the circuit should be powerful enough to secure prompt and regular action." In the tests of mechanical cut-outs the liability of the mechanical parts to fail through sticking has been found so small as to be negligible.

Pulleys Made of Paper.

THE less weight a shaft has to carry, the less will be the power it consumes in friction. The pulleys mounted upon shafts often form a considerable part of the weight the shaft bearings are required to support. If any part carried by these bearings be out of line, or out of running balance, the result of such defects upon the waste of power will increase with the increase of weight in the defective portion. In most cases it would be desirable to run shafting as light as is consistent with required rigidity, and pulleys as light as is consistent with the service they are needed to perform. The use of any material that could give an increase of cohesion, or, in the case of friction pulleys, an increase of adhesion, would be a distinct advantage, if this gain could be made without sacrifice of other essentials. From this point of view experiments made by Mr. Geo. D. Rice, with paper as a material for pulleys, the results of which he communicated to *The Iron Age* (Feb. 11), are not without interest, and may prove of importance to the mechanical world. The

pulleys experimented with were of two kinds, one of paper pulp compressed between metallic flanges, and the other made up on the lag principle. In the first-named kind the flanges have hubs, which may be attached to the shaft by set-screws or keyways, and the paper filling between the flanges is attached to the latter by a series of through-bolts inserted at a uniform distance from and parallel with the axis of rotation of the pulley. In this form the paper filling between the flanges is an integral disk with a hole in the center; in the second the lags are of the form which would be obtained by cutting the above-described paper disk into two semi-cylindrical parts by a plane passed through the axis of rotation. The clamping between the flanges is done in the same way for both forms of pulleys. Two different kinds of paper stock were used, one kind for the first form of pulley, and another for the second form; but we do not gather that this is required as a consequence of the different construction of the pulleys, and suppose, rather, that the modification was merely for experimented purposes. It seems that the stock found best for one form would also be best for the other. "The stock for the disks was made from ordinary straw boards, which, after being compressed, was cut into disks, cemented with a special glutinous mixture, clamped in the flanges, turned down, treated to a coating of wax and tallow, smoothed, and polished. The stock for the lags was made from a combination of book and rag material, received in pulp form and pressed into molds." The reduction in bulk by compression (shown by a diagram accompanying the article) appears to be nearly two-thirds of the mass put in the mold. Repeated applications of pressure were required to condense the paper to a degree that qualified it for use in drive-wheels. After compression, the lags were heated to 210° F. in an oven, and kept at this temperature for fifteen hours. The residual moisture was thus dried out. The lags were next bolted to the flanges, turned in a lathe, and treated with the dressing made of wax and tallow, above mentioned. Sand-papering and polishing finished the wheels. A special machine was made to test these wheels. This machine and its application are illustrated and described in Mr. Rice's article. We note here a few of the results. The two types of construction produced wheels capable of withstanding about equal pressure (550 pounds per square inch), without yielding. At 775 pounds' pressure per square inch one of the wheels was crushed. Under a pressure of 165 pounds per square inch an increase of resistance to slipping of twelve per cent. in the paper as compared with leather surfaces was shown. "Over one surface iron, one wood and the other paper, one raw hide and the other leather, there was an increase in favor of paper each time. In another experiment a 6-inch leather belt was run on 20-inch pulleys at a speed of 900 feet per minute, developing 10 horse-power with a slip of 6 feet per minute when subjected to sprays of steam from jets . . . which was done to find out the action of the paper surfaces under the influence of steam." A flanged rim and spoke pulley with paper lagging between the rim-flanges gave, it is said, good service.

The construction of this pulley is peculiar. The rim and also the spokes down to about half the radius are split in a plane at right angles with the axis of rotation. Through-bolts pass through holes in the spokes. When the nuts of these bolts are screwed tightly down, the two divided parts of the rim are forced toward each other, thus clamping the paper lagging between them. We incline to the belief that there may be a future for these wheels. We have no means of comparing their cost with that of iron pulleys, but can not see that they can be materially cheaper; we should judge, on the contrary, that their cost might exceed that of metal pulleys.

Strength of Timber.

THE continued acquisition of data on this subject was noted in the remarks of Mr. Walter G. Berg in the course of a discussion at the sixth annual convention of the Association of Railway Superintendents of Bridges and Buildings, held in Chicago in October, and primted in the

report of the proceedings of the convention issued during the past month.* Those desirous of obtaining references to the latest literature and data of the strength of timber will be aided by Mr. Berg's remarks. After noticing the wide and favorable attention given by the technical press to the previous year's report of the committee of the association upon "Strength of Bridge and Trestle Timbers," he names additional data which have become available since the publication of that report. These are as follows: Bulletins No. 10 and No. 12 of the United States department of agriculture, division of forestry, the first entitled "Timber," the second entitled "Economical Designing of Timber Trestle Bridges." The latter contains the 1895 report of the committee, above referred to. The "Mechanical and Physical Properties of Southern Pine" are treated in Circular No. 12 of the department of agriculture, and a bulletin on the "Principles and Practice of Dry Kilns" is announced as in preparation. In *Engineering News*, June 25, 1896, are published extensive data of tests carried out by Mr. William Hood, chief engineer of the Southern Pacific Railway. Extensive tests of Pacific coast timbers have been in progress during the past year in the department of civil engineering of the University of California. Republished from the *Technological Quarterly* in pamphlet form, are now available the "Results of Tests Made in the Engineering Laboratories of the Massachusetts Institute of Technology." Results of tests of Washington fir and eastern white oak made by Mr. O. D. Colvin for the Northern Pacific railroad are contained in the *Railway Review*, March 7, 1896. Notes on white pine timber are also to be found in the issue of that journal for March 28, 1896. *The Inland Architect* for August, 1896, contained an article by F. E. Kidder on "The Proper Unit Stresses for Timber," which was republished in the *Railway Review* in its issue of October 3, 1896. The proceedings of the twenty-ninth annual convention of the American Institute of Architects (held last summer at St. Louis) comprise notes on the strength of timber by Mr. George W. Bullard of Tacoma, Washington, and by Prof. J. B. Johnson of Washington University, St. Louis. Lastly, Mr. Berg presents a straight-line formula adopted by Mr. J. E. Greiner, a member of the association, for the new 1896 issue of the "General Specifications for Bridges and Buildings of the Baltimore & Ohio Railroad," to which he adds a diagram showing various formulæ for yellow pine columns in comparison with actual, full-size tests, which diagram embodies data comprised in a similar diagram published in the proceedings of the American Society of Civil Engineers. For Mr. Greiner's formula and his reasons for its adoption, the printed proceedings of the convention above named may be referred to. Mr. Berg has done a public service in thus collating the references to the more recent data, at a time when engineers are so actively engaged in investigation of the subject.

* "Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir, and Oak."

Municipal Plants.

THE issue of *The Electrical Engineer*, for February 17, is largely devoted to an exposition of the views of electrical engineers upon, and a broad review of, the subject of the municipal control of electric-lighting plants, in which it takes the position hitherto maintained by THE ENGINEERING MAGAZINE that neither experience or logic warrant the belief that the public would get better service by an extension of the system of municipal control. It holds that a general adoption of municipal control and operation of electric-lighting plants would be adverse to the interests of the public. The data presented in confirmation of this view are extensive, and, we think, ought to be convincing. The candor and willingness of our contemporary to give both sides a show is manifested by the presentation of what is perhaps one of the ablest efforts on the side of the partisans of municipal plants, a report of Commissioner A. E. Winchester of South Norwalk, Conn., who has collected data from some three hundred mu-

nicipal undertakings. Mr. Winchester is very highly complimented for his ability as a municipal officer and his skill and acquirements as an electrical engineer. Notwithstanding, his report is not convincing. "In most instances the balance-sheet is decidedly unfavorable, and in many cases there appears to be no knowledge that such a vital factor as depreciation must be taken into account. Even Mr. Winchester, stanch champion as he is of municipal plants, is slow to approve of them for large cities." He appears to think there is a higher standard of official morals in country towns than in the greater commercial centers, which may be the fact; but, if it be desirable to maintain this standard, the surest and quickest way to destroy it is to multiply opportunities and temptations to wrongdoing by extension of the system of municipal operation. We hardly intended this notice to do anything more than direct public attention more strongly to the good work of our contemporary, an adequate review of which could not be made in the space at our command. The editorial and other matter relating to the subject in the issue named should be itself consulted to gain a broad idea of the present attitude and arguments of those favoring, as well as of those opposing, what is fitly styled "the municipal-plant craze."

The Copper Mines of Arizona.

PROF. ARTHUR LAKES, in *The Colliery Engineer and Metal Miner* for February, has an interesting description of the mineral resources of Arizona, dwelling more particularly upon the deposits of copper, which he declares to be "the largest and finest we know of in the west," adding that "Arizona is a country not too well known, nor over-advertised for its mineral wealth." Attention is directed to the large increase in the output of precious metals in Arizona. The yield of gold from her mines was $4,260,000 in 1895, or quadruple the output for 1893. Mr. Lakes predicts that "at the end of the next fiscal year the production of gold in Arizona will have reached $10,000,000," basing this prediction upon "the large number of new gold discoveries, the rich developments being made, and the number of reduction works being erected, as well as the enthusiasm displayed among prospectors and the eagerness of capitalists in gold mining." What is true of the progress in the mining of gold and silver is true of the copper output. A field of great promise has been opened within forty miles of Tucson. Large deposits of sulphid of copper exist "in the region of the Grand Cañon . . . which only await the advent of transportation facilities to become large producers." A copper mine which, it is predicted, will yield copper bullion for a century to come is located at Bisbee, Cochise county. "These mines and smelters are worked night and day, and employ 1,000 men. The average daily output is 37,000 pounds. Large copper deposits and mining industries exist also in Gila and Maricopa counties; but the most phenomenal mine of Arizona, as well as of the west, in its way, is that of the United Verde (gold, copper, and silver), producing 150 tons daily. A letter from a prospector is quoted as saying that, with the big machinery,—150 tons' capacity,—there is ore in sight in this mine for 150 years. The output in 1894 is stated to have been $1,500,000 in gold, $7,500,000 in silver, and 11,000,000 pounds of copper. Strange as it may seem, this rich mine is very little known to the outside world. The prospector quoted, who signs himself C. A. R., asserts that people not more than twenty miles distant from the mines know only that there is a mine located there and being worked, but have no idea of the great wealth of the deposit. He makes some astonishing statements as to profits, which we prefer not to reprint, as we do not know how far they are warranted by facts.

Fast Long-Distance Run—A New Record.

THE possibilities for higher speeds on railways have found another demonstration in a special run made on February 15 over the Chicago, Burlington & Quincy and the Burlington & Missouri railroads, from Chicago to Denver. A detailed description of this run, with editorial com-

ments, is given in *The Railroad Gazette* Feb. 26). The special train consisted of an engine and a private car, chartered by a gentleman who was very anxious to reach Denver before the death of a son lying dangerously ill in that city. The train left Chicago at 10 A. M. For this special service one dollar per mile was paid, the distance being 1,025 miles. No guarantee for the time in which the run should be made was given. It is said that the intention was to run about as fast as the fast mail trains. Only after the train was well on into Iowa was a record run decided upon. Orders to run as fast as consistent with safety were then given. Twenty-one station stops were made between Chicago and Denver, these stops, in the aggregate, consuming sixty-four minutes.

Deducting this aggregate from the total time between the two points, the actual running time was 17 hours and 49 minutes, the average speed being 54.27 miles per hour. There are, as our contemporary points out, some very significant features in this performance. No special preparation was made, or even thought of, in connection with it. "Generally, in preparing for a special fast run, a season of the year is chosen when suitable weather is assured, and the track is in the best condition. The locomotives are carefully chosen and put in good order, special arrangements are made that the track shall be clear far in advance of the train, and all officers and employees are notified to be in their proper places. Often watchmen are stationed at grade crossings along the line, . . and main track switches spiked. Everything which could cause delay is anticipated." The remarkable performance above noted is characterized by the entire absence of special preparation. The train started in a snow-storm, hauled by an engine that had been fifteen years in use and was recently employed in the freight service." In view of all the facts, *The Railroad Gazette* is right in styling the feat "a triumph of discipline." Only careful organization and training throughout all departments could have rendered it possible.

Continuous Records of Marine Engine Performance.

In no department of engineering are exact data more necessary than in tests of marine-engine performance. After every trial of a new steamship, a mass of data are recorded, and, if the ship be one of importance, these data are generally printed in the technical journals in connection with a more or less detailed description of the engines. In this form they are generally looked upon as of sufficient accuracy to indicate what may be expected in continuous running. Prof. W. F. Durand, in *Journal of the American Society of Naval Engineers* for February, asserts that such data are far from furnishing information from which a "continuous record of performance can be deduced." The indicator cards are not taken with sufficient frequency. Ten- to fifteen-minute intervals are too long, giving too much room for variation in mean effective pressure, and the counting of revolutions for one minute out of fifteen can not give a very close approximation to the mean number of revolutions. The margin of possible error in a single minute's counting always involves a fraction of one turn, and, unless experience and care are applied to the counting, it may reach a still larger figure. Prof. Durand, therefore, advocates a reform in the method of conducting tests. He shows—satisfactorily, we think—that indicator cards must be taken at five-minute intervals to insure that the error shall be not greater than one per cent., and that this degree of accuracy can be relied upon by the use of methods of procedure which he prescribes. We cannot attempt to give these methods in detail here, but shall note their general character. In dealing with mean effective pressure, an experimental determination of a general relation connecting the mean effective pressure with the initial pressure and vacuum is first made; next, a continuous record of the vacuum; and from this record and the previously-determined relation a continuous record of the mean effective pressure may be determined. The continuous record of the vacuum and the initial pressure is easily secured by the

use of recording gages. Prof. Durand says that "the relation sought must be determined by experiment, and consists, in fact, of a calibration or standardizing trial, in which the steam pressure and vacuum will be determinately varied, and indicator cards will be taken." He illustrates this by an example which shows it to be easily practicable. The method of interpolation enables the record to be completed for all values of initial pressure and vacuum between the limits of the observations. In the absence of recording gages, gage readings each quarter of a minute will enable a close approximation of initial pressure and vacuum to be made. The continuous record of revolutions may be made by a recording tachometer. "In default of such instruments, we may, instead, read the counter every quarter or half minute, putting down the numbers in succession, but making no attempts at subtraction to find the differences." Now, in these procedures and operations Prof. Durand shows that absolute accuracy is not so important and desirable as "relative correctness of value. With correct relative values and the true total integration of the revolutions, as given by the counter . . . the record derived may be made correct, both relatively and absolutely," and, "this being done, we shall have continuous records of both mean effective pressures and revolutions, and hence, by their combination, a continuous record of the work and power in each end of each cylinder, and hence, by summation, a continuous record for the power as a whole." The exposition of the method is followed by an account of its application to a trial of the engine power of the steam yacht Clara on Cayuga Lake. The yacht has a length of 91 feet, a beam of 11.9 feet, a draught of 3 feet 5 inches, and a displacement of 40 tons. The engine is compound, having cylinders 10 inches and 19 inches in diameter, and a 12-inch stroke. The record of this trial is an interesting study. The value of the mean power was found to be 105.23. A comparison of this with results obtained by cards taken off at intervals in the usual way shows not only wide differences depending on the time interval between cards, but also wide differences between the results of the tests made at the different time intervals. Out of a number of examples we cull two striking ones. "With intervals of fifteen minutes, the first card being taken at seven and one-half minutes from the beginning of the run, we have 115.3 as the mean power. With intervals of fifteen minutes, the first card being taken at the beginning of the run, we have the value 95.7. There is a difference here of 19.6 between the results of the two tests; while, as compared with the result obtained by the continuous-record method, the first of the two tests gives a result 10.07 too large, and the second gives a result 10.16 too small. Only when cards were taken at intervals of not more than from three to four minutes was the error reduced to less than one per cent. During the trial the fluctuations of conditions were such as would not ordinarily be met with." The author admits that this makes the range of error in the trial of the Clara more than usually wide. The paper concludes with a consideration of changes of condition most likely to occur between the calibration and actual trial. Plottings of results are given upon infolding plates.

Principles of Design.

MUCH that is written upon the subject of architectural design must appear mere rubbish to professional as well as lay readers. Given a certain familiarity with the technology of art, a facility acquired by practice in what we may style the cant of art literature (for there is such a thing as cant in art talk as well as in religious and moral discourse), and a vivid imagination, trained or otherwise, and it is easy to dash off something almost or quite worthless, which nevertheless may impress the shallow reader as profound. It is pleasant to say that a paper on "The Principles of Design" by W. A. Langton, in *The Canadian Architect and Builder* for February, is not of this superficial character. The author has something to say that is really helpful, and says it tersely, clearly, and without affectation. He first alludes to those principles in design—as, for example, "honest construction and truth to

material"—which, as he forcibly expresses it, "approach to moral qualities"; but he immediately dismisses this as a trite topic, and turns to the "details of handling in search of rules or principles which may be guides to help the eye in matters of taste, just as an elementary knowledge of perspective is often a guide to the eye in drawing an object, when it is difficult to decide by the eye alone whether a line is horizontal or sloping, or which way it slopes."

Thus it is possible to discover a law of fitness(for example, in the proportion between capitals and columns, or between capitals and piers) which will prove at least a rough guide to design. This idea is elaborated and illustrated by reproduced drawings which exemplify the principle of fitness as applied to the design of a capital and base; showing that, in the effort to produce such a design, thought is directed to the expression of the use of a capital in a beautiful manner rather than to emphasis upon its structural usefulness and the way in which it is useful,—to wit, as a means for concentrating a large load upon a small shaft. However, a design proceeding in this manner does emphasize the structural facts, but this appears as a concomitant result rather than a principal purpose. "Where there is small superincumbent weight, it is more pleasing to have the column small and even fantastic. For instance, in the Lombardic fronts of Pisa and Lucca, where the columns stand over one another for ornament and support nothing, it would cease to be ornamental, and be merely dull, if they were sober, business-like columns, instead of being what they are,—small inlaid, twisted, knotted, composed of a pile of animal forms, or even with the upper and lower parts looped together, as if for tension." The capital not being strong transversely, the deep bell form becomes essential for small columns, etc. Heavy caps on piers, having no expression, are condemned as a mistake in design. With reference to round and flat arches also the author discourses intelligibly and sensibly, illustrating this part of the paper with drawings and diagrams, and bringing out, among other principles, that, "as a rule, in masonry what looks strong enough has an excess of strength, so that, if we are to make an arch look right, we must go beyond the consideration of statical needs, and give some consideration to artifices by which the curved lines of the arch (the chief indicators of its restlessness) may be composed. One of these is uniformity in the springing line. This is a point often disregarded when the arches, though visible together, are not close together. When the openings form a regular arcade, the need of making the arches spring from the same line is clear; but it does not seem to be so clear that there should be a springing line for each story, just as definite as lines of strings and cornices which indicate the floor and ceiling levels. It is not a question of real stability, but one of repose, gained by the composition of lines, and, though ample piers may be between them, arched windows which spring from below the heads of square-headed windows in the same story can never be as pleasing as those which spring from the level of these heads." This fault is as objectionable in interior as in exterior design, and the old colonial style is named as presenting many good examples of the right treatment of round and square-headed openings. As the author puts it, "the difference between simple expression and artistic expression is that one lays the facts before us, leaving us to find out for ourselves what they are," while the other "puts them in such a way that they strike at once, without one's having the trouble to think at all. That is what makes the artist. He is not content until he has expressed the matter so that it will impress some one else." The means at the disposal of the architect for this end are reviewed, and useful hints relating to their proper treatment are presented. While there is always something to express, there is not often much, and "in all cases minor things must be subordinated, and the principal expression given to those which are important."

THE BRITISH PRESS

The Promise of the American Iron Trade.

ONE of the most significant recent movements, of joint interest to the metallurgical, mechanical, and commercial world, is the promised development of an American export iron-trade.

It is not unnatural that the expectation on this side of the water should be often over-enthusiastic, nor, on the other hand, that British comment should show a tendency toward undue slighting of the importance of the matter. It is, therefore, of particular interest to notice the thoughtful and dispassionate review of the situation which is afforded by so eminent an authority as J. Stephen Jeans, in an editorial entitled "The Lights in the Window," published in a recent issue of the *Iron and Coal Trades Review*.

Mr. Jeans briefly reviews the "considerable amount of talk, and probably not a little alarm," which has been occasioned in some quarters of Great Britain by the threatened success of American iron and machinery firms in securing control of large European orders. "Some of the daily newspapers," he continues, "have deemed it worth while to give an unusual amount of attention to the subject, and one of them at least has spoken of the American imports of iron and steel as causing a scare in iron-making circles here. There is hardly sufficient truth in this exaggerated manner of putting the case. We do not believe that many of those who really know the facts are apprehensive that we shall suffer much harm from the threatened deluge of American iron and steel. We may, however, experience periodical visitations of the same sort of panic. We did so upwards of a hundred years ago, when attempts were made to induce parliament to stop the importation of iron from our American colonies. American competition loomed largely in the mental horizon of Richard Cobden when he wrote, more than fifty years ago, that it was to the industry, the economy, and the peaceful policy of America, and not to the growth of Russia, that politicians and statemens of whatever creed ought to direct their anxious study, for it was, he said, by these, and not by the efforts of barbarian force, that the power and greatness of England were in danger of being superseded. The danger which Cobden then foresaw, with a rare prescience, is, no doubt, more imminent to-day than it has ever been before, but it is not, for that reason, irresistible."

But yet, Mr. Jeans admits, "the Good Ship 'British Industry'" is in some danger, and watchfulness is needed to keep her off the "rocks of apathy and inadequate preparation for meeting new conditions. There is no gainsaying the fact that certain American firms, and more especially the Carnegie Steel Company, have, by recent business deals, become the masters of enormous stores of cheap raw materials, as well as of cheap transport. By great engineering talent and unique administrative capacity, the same concern has succeeded in blotting out the differences in the cost of labor that previously hindered American manufacturers from hoping to land American products on European soil. The only difficulty now standing in their way is that of space. Situated nearly four thousand miles from the markets they aim to conquer, it would appear, on the first blush, utterly impossible that they could ever hope to compete with English manufacturers on their own soil. But the seemingly impossible has become a stern reality. To what extent the passing reality of the present may become the permanent reality of the future, no one can prophesy with confidence. If England had the same cheap transport, and the same perfect economical appliances and systems that are found in the United States, the latter country, despite its rich ores and its cheap fuel, could not compete with us for a moment. What is, then, to be done? We must clearly prepare ourselves to wage the warfare that is imposed upon us by our economic conditions. Let us get well to the front, and keep there. Let us cheapen our ores, reduce the cost of our fuel, improve the character and cheap-

en the cost of our transport, secure a higher range of technical skill, demand more competent and better distributed labor—in short, fight our American rivals with the weapons that they have themselves made use of."

Mr. Jeans, however, is perhaps disposed to attach too little importance to the permanent character of the movement, and unduly magnify the influence of temporary and fortuitous combinations of conditions. To quote his own words: "In other words, we believe that, when the next revival of American industry comes about,—as it is generally expected to do before long,—prices will rise to such a level that we are hardly likely, for a time at least, to hear much more of American competition. Nor is it probable that the extraordinary combination of favorable conditions arranged for by the Carnegie Company can be permanent. It is of such a unique character that it is a greater menace to rival manufacturers in the United States than it is to competitors in Europe. It is almost one firm against the world, and the world, in the long run, is bound to win."

From this view of the case we are bound to dissent, in spite of our profound respect for its distinguished author. We can not believe that the special circumstances and temporary conditions have done anything more than hasten the attainment of a mastery which in itself is ultimately dependent upon deeper-lying, permanent, and intrinsic qualifications. The same preëminent ability which has blotted out differences in labor-cost will win further victories, sufficient to overcome the "difficulty . . of space."

It is such concerns as the Carnegie Steel Company that lead the world. It is our prediction that, when the world has caught up to the present Carnegie standard, the continued and expanding exercise of the "great engineering talent and unique administrative capacity" will have placed the Carnegie Company as far in advance of the pursuing world as they are now in advance of their yet backward competitors. Our reading of history is that the leaders, and not the world, are, "in the long run, bound to win."

Education of German Mechanics.

In these days of rapid change, when machinery has already supplanted much of the hand labor of former times and is still lessening the amount of labor needed for a given output, the question of the training of mechanics for the positions they are destined to fill in the world of industry has been considered and reconsidered, and methods which until very recent times were unknown have been adopted. One of these is the modern trade school. The system of apprenticeship, though not so far abandoned as many have supposed, is, however, no longer a school to which almost any intelligent boy of good family and habits can apply with almost the certainty of admission. There are yet masters and apprentices, but, in proportion to the numbers employed in the various trades, the proportion of apprentices is relatively much smaller than it used to be. We do not class as apprentices youths employed to operate a single machine and who receive no other instruction than what is necessary in order to do that special work.

Of these there are many more than in the old days, when apprenticeship was a rule of every shop. Pertinent to the consideration of this subject is an article in *Engineering* (Feb. 12) on the "Education of German Mechanics," in which the claim is made that England can learn much from German methods. If this be so, it may be that these methods contain something worth considering by American educators also. German elementary schools are free, and children from the ages of six to fourteen are compelled to attend them. Compulsory attendance has been adopted in some parts of the United States, but, as in some cities where the system is legally required, the school buildings cannot accommodate the existing number of pupils, compulsory attendance has not been uniformly enforced, and its effects have not been fairly demonstrated. The course of study in German elementary schools does not differ materially from that usually taught in American schools to pupils under fourteen years of age. The next grade is the *Mittelschulen*, where French

and mathematics are added to the studies of the elementary grade. Then comes the *Realschulen*, or high school, in which to a more extended course in mathematics the study of English is added. It is thus seen that a youth who has passed through the three grades will know not only his native language, but also something of the two other important languages spoken by civilized races. In the highest grade of the Realschulen, Latin and Greek are included. The children of the poorer classes generally go no further than the Mittelschulen, which they usually leave at the age of fourteen; but in nearly every small town in Germany is an evening school,—continuation school (Handwerker-Fortbildung Schulen),—which boys of the working class are compelled to attend. These schools are mostly free. At some a small fee is charged, in which case it is paid by the masters of working apprentices, or the commercial firms that employ the youths who attend the schools. In these schools mathematics, drawing, English, French, book-keeping, etc., are taught. It is noted that German youths are thus kept under school discipline till they reach an age at which the value of education is generally appreciated. When a student enters a German technical school, he not only must have passed the elementary grammar schools, but also must have been for some time a practical worker in some trade. Attendance upon these schools is not compulsory; the fees are high, the examinations for admission are severe, and, as a consequence, the technical schools are filled with a good class of students. Those who desire an epitome of the German system of education and a comparison of it with that which prevails in England may find both in the very readable article we have named, in which the conclusion is reached that, while the German system has not made German artisans better workmen than the English, it has greatly promoted German trade and commerce "by equipping the manager, the salesman, and the commercial traveller with a stock of knowledge which would put men of the same class in England [perhaps, also, America] to shame."

The Goldfields of Western Australia.

IT is affirmed with great positiveness by Mr. Harry C. Rhys Jones, editor of the Perth *Mining Journal*, that the future of the great colony of Western Australia has been placed beyond the shadow of a doubt, and that it will be a brilliant future. He contributes an article to *The Australian Mining Standard* (Jan. 14), in which he makes this statement, following it up with a glowing description of the country and its resources: "Western Australia is a country of greatness. It is great in extent, great in its known wealth, and great in the vast possibilities which are opening before it, and it threatens to fulfil the declarations of some of the most sanguine of our mining men; who regard it as bound to become, in a short while, the greatest gold field the world has ever known." Language so strong as this, were it not supported, at least partially, by known facts, would sound rather too much like that of a mine boomer whose interest it is to magnify to the utmost the possible and probable resources of a region in which he owns claims; but there are some facts which seem to justify the enthusiasm of Mr. Jones. As compared with the gold fields of Victoria, the gold-bearing areas in western Australia are enormous, extending over hundreds of miles. Judging by the small proportion of disappointments, it is claimed that the country deserves the best that has been said of it. Delay in results in the majority of cases has been caused "by adherence to the rules of scientific mining." Meanwhile the development of the mines has progressed. "The development . . . is not occupying a longer time than would be the case elsewhere if the conditions as to distance and transport were the same." It is asserted that this delay, which has thrown some doubt upon the value of the gold properties will, not much longer continue, and that in less than six months the number of batteries in operation will be quadrupled. The statement made in some quarters that sixty or seventy millions of money have been sunk in the colony is denied, the truth being that probably not more than five millions have been ex-

pended on the gold fields. The scarcity of water for mining purposes even in the driest gold fields is also denied, though this has been widely asserted, to the discredit of the mining districts. "The cost of labor and the strange mining laws" are much more serious disabilities than lack of water. Skilled miners are badly needed. The ores are said to be "so rich that the loss of gold in treating them is not a matter of such importance as it would be to some other countries." On the whole, Mr. Jones's article would not be less impressive, were it a little less enthusiastic There is a sense of extravagance and exaggeration in it, to readers at a distance, which does not strengthen its effect.

A Possible Pacific Cable.

AN interview which a representative of the *Pall Mall Gazette* had recently with Prof. Sylvanus Thompson was made the basis of an article in that paper under the title: "The Pacific Cable Made Possible." The substance of what Prof. Thompson said to the *Pall Mall Gazette*, as reported therein, is reprinted in *The Electrical Review* (Jan. 29) with comments. It outlines a method of overcoming retardation in a cable, which, it is said, has not been previously published, though known to some electricians. Prof. Thompson is reported to have said:

"My cable has two separate conductors, each perfectly insulated and inclosed in the same armor. At intervals of every one hundred or one hundred and fifty miles I introduce stretches of cable with three separate conductors, the third being a wire of high resistance acting simply as a leak. One end of it is connected to the positive conductor, the other to the negative. In this way the static charge on the positive conductor simply neutralizes that on the negative, and, by introducing a sufficient number of such leaks, the retardation can be entirely got rid of." *The Electrical Review* points out the similarity of this principle to that explained in English patent No. 22,304 issued to Prof. Thompson in 1891. This patent describes compensators consisting of wires of high resistance coiled round a core of well-laminated iron joining the two conductors. The patent specification further says that "the coil is covered with insulating material, and its choking or its self-inducing action, if it consist of a sufficient number of turns of fine wire coiled near together, will cause sufficient resistance to prevent all but an insignificant quantity of the working charge to short circuit. In electric cables the induction coils must be further arranged so as not to form unwieldy enlargements of the cable, and are, preferably, long and narrow, and with the axis parallel with that of the cable." The new arrangement described by Prof. Thompson appears to be intended to supersede that described in the patent of 1892, and, in its editorial review of the proposed scheme, *The Electrical Review* admits that it would greatly increase the speed of signaling. It doubts, however, that speeds as great as appear to be expected would be realized. If the "resistance acting simply as a leak" be very high, "the retardation of signals due to static charge" will be considerable, "while the conductor resistance will be double that of a single core." An increase of E. M. F. of the signalling battery will be necessitated, probably developing a weak point near the end where the majority of faults occur. It is claimed that the change would involve no increase in the difficulty of repairing such a cable, but this, it is thought, must "depend on what the so-called stretches of cable with three separate conductors may mean. If several miles in length, and the repair entails cutting into one of these stretches, the whole stretch will probably have to be recovered, in order that the new cable spliced in may give approximately the same leak resistance as the cable requires at this point." Conditions of weather, depth of submergence, and the mechanical condition of the cable might conceivably make additions to the expense of repair that would not be necessary with a cable uniform throughout its length. It is further indicated that the difficulty of localizing faults in so complex a system would be greater than in an ordinary cable. In these and other criticisms any wish to minimize Prof. Thompson's claims for his

"rapid cable" is disavowed, the object being to make as clear a comparison between the old and the proposed new style of cable as present imperfect information of Prof. Thompson's system permits.

Modern Diving Apparatus.

It is said that there are no unexpired patents on diving apparatus. We are certain that the apparatus now in general use differs in no essential point from that used nearly half a century ago, however much advance in the way of design, workmanship, and material may be shown. But now, as then, this kind of apparatus forms an essential part of an outfit for the recovery of sunken vessels, and of property, from the bottom of the sea. Many interesting details of the construction and use of diving apparatus, as made by an English firm, are presented in an unsigned article in *Transport* (Feb. 12).

The first and paramount consideration in diving apparatus is that of safety. All considerations of convenience in use, storage, or conveyance must be subordinated to this, which is all the more imperative because experienced divers can not always be obtained, and unskilled laborers may be the only help available in some instances. The apparatus, therefore, in its construction, appearance, and record, should be such as will inspire confidence in the minds of those unaccustomed to its use. The English firm alluded to is credited with making an apparatus so simple and easily understood that it may be readily and successfully operated by laboring men who have never before used it. The advances of forty years have been in the direction of simplicity, utility, and durability. The exterior bars which were formerly employed to protect the three glasses of the helmet, and which more or less obstructed vision, are no longer used. The glasses are now made five-eighths of an inch thick, which gives sufficient strength. The front glass of the helmet does not unscrew and screw in as formerly, but opens on a hinged joint, like the scuttle joint of a ship; the diver, on coming to the surface, may open and shut this glass himself, without the risk of dropping it. The helmet, moreover, is supplied with an air valve that may be opened or closed by pressure of the diver's finger, but which, left to itself, closes automatically and remains closed. The valve, under ordinary conditions, is self-acting. It is placed at the side of the helmet, so that the escaping bubbles of the air do not impede vision. The dress is made with sufficient air-capacity to permit time for signaling and drawing up in case of an accidental stoppage of supply. If breakage of the air-supply tube occur, an automatic valve prevents the entrance of water through the tube. The attachment of the weights permits their instant removal when the diver reaches the surface. The air tube itself is a great advance from that once employed. It is composed of three layers of canvas with alternate layers of rubber, and an imbedded wire coil. The pumps employed are an interesting part of the apparatus. They are of three kinds: (1) a three-barrelled single-acting pump is used in pearl, coral, and sponge diving; (2) a two-barrelled double-acting pump is used on occasions where the services of two divers are required below at the same time, as is sometimes the case; (3) a one-barrelled double-acting pump is used in harbor or dock work, in depths up to eighty or ninety feet. The two-barrelled double-acting pump is also used by a single diver for deep-sea diving. For very shallow water, and such work as repairing leaks in ships, the one-barrelled single-acting pump is preferred. A great deal of care is bestowed upon the construction of these as well as all other parts of the air-circulating system of devices. The material of which the dresses are made is a strong twill, first made water-proof and then covered with a layer of pure rubber. Parts liable to more rapid wear than others, as the knees, elbows, etc., may be reinforced. Two thicknesses of the rubber-faced twill are placed with the rubber faces together, and pressed into a single sheet, which is then made up into the dresses. The boots are made of thick, soft calf-skin. From the air supplied to the divers the heat acquired during compression is removed by passage through a copper cooling cistern.

Suction Draft for Marine Boilers.

THE still unsettled state of opinion upon the merits of what are respectively and technically known as forced and suction draft applied to marine boilers was alluded to in the introductory paragraphs of a paper read before the Institution of Engineers and Shipbuilders in Scotland at Glasgow, January 26, by Mr. Matthew Paul. For the information of laymen it may be said that forced draft is brought about by continuously pressing air into a stoke-hold made practically air-tight, except for the draft passages of the furnaces through which the air passes, under the combined action of exterior atmospheric pressure and the mechanical means (usually a fan blower) employed to increase this pressure. Suction draft, on the contrary, aims by mechanical means to increase the flow of air through the furnace by lessening the atmospheric pressure opposing the escape of gases from the uptake and smoke-pipe. In the forced-draft system the cool outside air at its normal density has to be passed along by the action of the fan-blower with a slight increase of density; in the suction draft the gases of combustion, added to the normal volume of air needed for combustion, both expanded by heat, must be handled. To most people, we should think, the forced-draft system would appear the more simple and practicable; notwithstanding this, an argument of considerable force can be made for the suction system, and such an argument is made in the paper referred to for suction draft broadly, and especially for a patented system known as Patterson's, exemplified by experiments made at the works of Messrs. M. Paul & Sons at Dumbarton. First it was maintained by Mr. Paul "that, until the advent of some more commercially successful type of water-tube boiler than has yet been produced," the majority of ships will use mechanical draft. The merits and demerits of the plenum system as related to the life and safety of the boiler, the rates of combustion and evaporation, etc., were briefly mentioned, and were made the subject of comparison with the suction-draft system. Proceeding, the author (as reported in *The Engineer*, Feb. 5) asserted that with forced draft a plenum of three inches was required for a consumption of sixty pounds of coal, per hour, per square foot of grate, and that a consumption of one hundred and eight pounds per square foot of grate, per hour, requires a plenum of nine inches. He asserted it to be "a matter of common knowledge that endless trouble was experienced when an ordinary tubular boiler was worked under forced draught at rates considerably less than those named, and that no attempt to attain them in ordinary sea-going work, over lengthened periods, had yet been successful. Even for short trials, extending over a period of four to eight hours, the boilers had failed repeatedly, with air pressures as low as 2 to 2½ inches, when burning forty-five to fifty pounds of coal per square foot of grate per hour, and the result was that the boilers were increased sufficiently to do the required work at greatly reduced rates" Mr. Paul declared, however, that with suction draft the case was entirely different, and sustained this proposition by reference to satisfactory results of admiralty trials on various ships of the British navy, and to trials of suction draft under what is called the Ellis and Eaves system, made by Messrs. John Brown & Co. at Sheffield, which showed a coal consumption of from forty to sixty pounds, with high efficiency and without any trouble with the furnace bars, even when hot air was supplied beneath them. Mr. Paul described Patterson's system as being Martin's system with a water spray discharged radially from the center of the fan to keep the latter cool and prevent its being injured by the heat of the discharged gases. The author admitted that no satisfactory reason for the greater immunity of boilers with suction draft at an equal rate of fuel consumption, as compared with boilers employing forced draft, has yet been given; but he held that the fact asserted has been amply substantiated by experimental proof. In conclusion, it was maintained that suction draft has distinct advantages over forced draft sufficient to counterbalance increased size and cost.

Car Ferries of the Great Lakes.

AN illustrated description of craft used for transporting cars as variously constructed is an interesting feature of *The Engineer* (London, Feb. 5) which introduces the subject with remarks upon the development and present extent of the system. The boats are "constructed to accommodate a train of cars, and not only to cross the lakes with these in the summer time, but to cross in winter also, when they have to cut their own way through the heavy ice. At first car ferries were used only at few points, where the waters were narrow and . . . bridging was not permitted. But now Lake Michigan is crossed at several places, and one line runs up and down almost the entire length of the lake parallel to the shore. In the latter case the ferry line is much longer than the railway which it serves. When it is remembered that a car ferry has to carry a greater weight of cars than of goods (less than half the cargo pays, and the remainder is dead weight), and that the largest car-ferry boat carries less cargo than would be taken by a smaller and less expensive steamer, it seems that there must be little profit in operating them in places where they are not an absolute necessity; . . . but the car ferry is to all appearance a success. A great deal of money has been invested in these lines by shrewd business men, and several new routes are being considered, so that the car ferry may be said to have passed the experimental stage and become one of the fixed institutions of the lake." The heavy terminal and transfer charges at Chicago are assigned as causes of the growth of the car-ferry system. The boats carry through freights only, and, as the competition on through freight is sharp, it is all the more remarkable that they can do a paying business. As for a time in winter these boats are the only ones navigating the lakes, it may be that they are able to reap an advantage from this circumstance. The beginning of the extension of the car-ferry system to longer distances than the width of the St. Clair and Detroit rivers dates back to "the building of the screw steamer Algomah, in 1881, by the Detroit Dry Dock Company." The boat was built for the Mackinac Transportation Company, which included the Michigan Central, Grand Rapids, and Indiana and South Shore Railways; and the boat "was intended to serve as a connecting link at the Straits of Mackinac." Though not intended to carry cars, and although a failure for winter navigation, this boat demonstrated possibilities which have been realized in subsequent car-ferry boats. The winter navigation of the straits of Mackinac presents extreme difficulties. "The straits form a storm center, and are assaulted in all directions. During the late autumn and early winter the winds make a foot-ball of the rapidly-forming ice. First it is driven in from Lake Michigan, piled up by the surf along the shore, and hurled crashing against the frozen surface of Lake Huron. A change of wind then sets the latter in motion, and the aggressor is forced back, grinding and thundering. The fields of ice collide and break, and all along the meeting edges the smaller pieces are thrown above or forced under the larger ones. With mortar made of seething spray and driving snow the contending fragments are cemented into shapeless masses, which drift against each other, forced this way and that by winds and changing currents, until, in the ever-increasing cold, the passage is finally blocked. The surging mass of hills and valleys, of sharp peaks and deep depressions, becomes quiet and rigid. Day after day the frost makes more firm the bonds by which this irregular surface is held together, and the straits of Mackinac are closed for the winter. At places the ice extends twenty feet above and twenty feet below the usual water surface, and along the shores it is often frozen to the bottom at that depth. Great windrows extend up and down, and across, like miniature mountain ranges, marking the meeting places of fields of ice." The encounter with ice of this character was far too much for the Algomah, although she had the spoon-shaped bow of the more recent car-ferry boats, and was fitted with a powerful engine; but she served to indicate what was still lacking for a successful win-

ter boat,—to wit, greater weight, greater power, and means at the bow for breaking up the windrows and working through the broken ice. The steamer Ignace, designed by Frank E. Kirby, was then built by the Detroit Dry Dock Company for the same owners, and she proved, with her 1,199 tons' measurement, and her heavy propeller at the spoon-shaped bow, operated by an independent engine, to be a grand success. She set the pace for all the boats of this type that have been since constructed. Twelve freight cars can be carried at once on this boat. Subsequently-constructed boats are described, and the routes which have been established are indicated on a chart of the American lake system which accompanies the article.

Insulation Resistance of an Electric Installation.

"WHEN the wiring of a building is completed," says *The Builder* (London, Feb. 20), "it has to pass certain tests before the public supply company will switch on the current. What these tests are can only be vaguely guessed at, as the supply companies talk learnedly in their rules about insulation resistance, and yet, when the consumer tries to find out what electricians mean by the insulation resistance of the wiring of a building, he will find out that it is a vague expression used in different senses by different people. He will probably be told by the consulting electrician that it is a measure of the leakage-flow between the house mains; this is the favorite definition, and, being the simplest, is strongly adhered to by youthful electricians, who think they understand it. How this is measured is clearly described in a well-known work on electrical engineering, published recently and . . . most favorably reviewed by the electrical press: 'All that is necessary,' says this book, 'in testing the insulation of any circuit, is to connect the + and — mains (the insulation between which is to be measured) to the terminals, turn the handle, and the needle at once points to the resistance.'" This quotation is cited to show that it is little to be wondered at that apprentices and wiremen imagine that they know all about so simple a matter. If, however, observation be directed to the inspector of the supply company, he will be found measuring the resistance between each house main and the earth, and, if this does not come up to his views, "he will refuse to switch on the current." Insurance inspectors follow in the same line. "All this time the intelligent consumer is guessing, as he is unable to get any definite information from the secretary of the supply company, and electrical books are hopelessly contradictory. He may think he has found it at last in a new copy of fire-office rules, but, on turning up this, he finds that the insulation resistance has to be measured when all current-consuming and current-producing devices are turned off; and so he gives up the hunt for a definition, and regards electricians as a slippery and unsatisfactory kind of people." The difficulty lies not in the theory of insulation-testing, but in the interpretation of what is meant by it in specifications. It is shown that accurate values of insulation resistance—contrary to the opinion of many—are worth more than the slight extra labor of calculating them according to a method explained in the article by formulæ and diagrams. The numbers ordinarily given may vary widely from the truth. A numerical example used to illustrate this point shows that an error of from two hundred to three hundred per cent. is possible in the ordinary way,—"a matter of great importance when current is taken from a company supplying on the three-wire system"; and the method for easy and accurate testing of insulation resistance by architects and consumers with the assistance of a wireman, as given, will, if studied, clear up the whole matter.

Difficulties Pertaining to Deep Rock Boring.

ON this subject *The Colliery Guardian* has recently given some interesting information, partly abstracted by J. W. Pearse from a paper read by Mr. Charles Zundel before the Société Industrielle de Mulhouse. The difficulties encountered sometimes compel the abandonment of a bor-

ing after a large sum has been expended. Mr. Pearse says that the deepest bore-hole yet put down is at Paruschowitz in Upper Silesia, which work "was undertaken for establishing the government rights to certain coal deposits." The depth of the bore thus made is 2,003.34 meters. The bore passed through eighty-three coal seams, the aggregate thickness of which is 89.5 meters. "Begun with a diameter of 32 centimeters (12 inches), with lining tubes 10 millimeters ($\frac{13}{32}$ inch) thick, the hole was put down to a depth of 70 meters (38 fathoms), from which point to 107 meters (58 fathoms) the diameter was reduced to 27 centimeters (10 inches). At this depth the blue marls were so compact that it was found necessary to resort to diamond boring. Moreover, under the action of the water injected into the hole, the marl swelled, and subjected the lining tubes to such compression that it was found necessary to gradually reduce their diameter." Shifting sand was encountered at a depth of 200 meters (109 fathoms), and much retarded progress. The weight of the boring rods in these deep holes is the greatest difficulty which engineers have to meet in this kind of work. It was this that ended the Paruschowitz boring. Notwithstanding the substitution of steel for iron, the total weight reached 13,707 tons. A breakage occurred; the lower part of the rods became so jammed in a yet untubed part of the boring that it was impossible to raise them. The cost of this boring is stated to have been 37.60 marks per meter. The temperature at the total depth reached was found to be 69.3° Cent.

Water Gages for High-Pressure Steam Boilers.

IN a former number of this magazine, while discussing the practical limitations of steam pressure for power purposes, the frequent breaking of the glass tubes of water gages at high pressures and temperatures was named as one of the minor difficulties which, up to a recent period, has formed one of these limitations. The employment of talc or mica gages has in some measure removed this disability. It is scarcely necessary to specify the inconveniences or (especially with rapid steaming boilers having a comparatively small water capacity) even the dangers that may follow the breaking of glass gages. An article on this subject by Mr. T. C. Billetop in *The Colliery Guardian* enumerates some of the ways by which it has been sought to remove or lessen this difficulty, the talc gage being the latest device for the purpose. It seems, however, that the glass gage is not yet by any means shelved, the talc gage being held in reserve for use in case of the breakage of the glass gage. The risks in the use of the glass gages have been lessened by the following devices. "Cocks have been made with automatically-closing ball-valves, which, however, have never become favorites with engineers, who wisely keep clear of complications in such important fittings. Hand gears have been commonly introduced for shutting off. Guards of plate glass or of wire have been fitted round the gage. Special makes of glasses have been tried. Glasses have been annealed or coated internally with different kinds of varnish, but, with it all, the same uncertainty exists. One glass might last a week or a month, another one minute. The causes of these failures cannot always be defined; for, while bad workmanship, clumsy or careless handling, or unusually trying conditions can easily be traced, it is very often impossible to state reasons why the glasses break. Various theories have been advanced, such as the special condition of new glass tubes, the cutting action of the steam at the top of the glass, damage due to condensation, etc." Want of homogeneity in the glass, even in glass of the same make, is also a probable cause. It is certain that under high temperatures and pressures glass will succumb to shocks and strains which it will endure at less pressures and temperatures. To obviate sudden changes various protective devices have been resorted to. Some steam-tight glass guards, so arranged that, in case of the breakage of the glass, the guards form a substitute for it, have not proved very effective; the sudden breakage of the inner tube is often sufficient to cause the breakage of the thicker

guard. Talc is a material which, while transparent, is also strong enough to withstand the pressure; it is, moreover, not liable to crack under changes of temperature. But this substance, answering excellently well at first, rapidly loses its transparency when in use, and after a time becomes useless from this cause. This opacity takes place near the water line. It appears that, while it will remain transparent when brought into contact with dry steam only, the heated water, on the contrary, produces some molecular effect upon mica which renders it thus opaque. It has, therefore, become the practice to fit boilers carrying high pressures with two gages, one of talc and one of glass. The glass gage is the one regularly employed. In case of the breakage of the glass gage, the mica gage can be immediately put into action, and used till the glass gage can be effectively repaired. Employed in this way, the talc gage can be made to last for a considerable period. It is now proposed to surround the glass tube by a gun-metal case fitted with mica plates into which steam enters at full boiler pressure, and out of which the small amount of water condensed in the jacket constantly drains. The glass tube thus would be kept at the same interior and exterior pressure and temperature,—a condition which greatly conduces to its durability. The mica will probably last much longer used in this way, but it is not quite evident that it can escape deterioration, as more or less water of condensation must come in contact with it. The free loss of heat from the exterior of this compound metal and mica case cannot be presented, unless covering it by glass is practicable. Even this would not entirely prevent escape of heat. If heat escape, condensation must ensue, and the condition of dryness in the steam essential to the preservation of the mica will more or less fail to be established.

The Brazil State Railways.

ANENT the proposed leasing of these railways to foreign capitalists *Transport* (Feb. 12) enters a protest against the brevity of the time (three months) allowed for the receipt of tenders. The condition of the roads is very bad, and, before making contracts or executing leases for property certain to require large outlays before it can be made remunerative (possibly to remain unremunerative for years), the capitalists who might invest in these properties will very carefully investigate the conditions and count the cost of putting the roads in working order. *Transport* thinks twelve months none too long a time for such examination and estimate, and predicts that capitalists are not likely to fall over each other in their haste to get control of the Brazilian railroads under the terms fixed upon by the Brazilian government, which has made a miserable failure in its attempted management of the railway lines. "It may be that the government will elect to accept the offer of any syndicate of speculators who intend to tranfer the property to a subsequently-organized syndicate. . . The government may, in that case, be able to realize on the lease sooner, but the syndicate will find it impossible to place the property with experienced railway men until a thorough examination and report have been made by trustworthy and competent men. The condition to which the between four and five thousand miles of railway which it is now proposed to lease have been brought by the grossest mismanagement is exemplified by the Central railway, which, it is estimated, would require an outlay by the lessees of £10,000,000 sterling. Such an amount as this will not be forthcoming in haste.

The term of the leases is sixty years, at the end of which the roads are to be returned in good condition and without indemnification."

THE FRENCH AND GERMAN PRESS

Protestant Church Architecture.

THE February issue of the *Oesterr. Monatscher. f. d. Oeffent. Baudienst* contains a long illustrated article by Herr F. Meldahl, in discussion of the question whether there has yet been evolved a definite style of Protestant church architecture.

Starting with the distinction between the Protestant and Catholic services, the former being based upon the hearing of a discourse and the latter upon the offering of the mass, he proceeds to illustrate the development of church buildings since the time of the reformation. Many of the earlier Protestant places of worship in German were chapels in the palaces of Protestant princes, and, in accordance with the decadent taste of the seventeenth century, the gaudy rococo school is very much in evidence in the illustrations of such chapels. The auditorium arrangement of seats, which has of late years come into vogue in some Protestant churches in this country, appeared in many of the Lutheran churches of the seventeenth century, although the cruciform ground plan, with the pulpit at the intersection of the nave and transepts, was a favorite form. The fact that the Calvinist form of Protestantism in France and Switzerland spread chiefly among the poorer classes until more recent times accounts for the meager development of church architecture in those countries. English church architecture is shown only by one example of Wren, S. Stephen's Walbrook, and one by Hawksmoor, S. Mary Woolnoth, so that what is probably one of the most influential forces in the development of a Protestant style of architecture is but slightly considered.

The article, however, is of interest and value in so far as it relates to the development of the subject in Germany during the seventeenth and eighteenth centuries.

Pier Foundations on Slopes.

IN the construction of the approaches to the new Kornhaus bridge at Berne, to which reference has already been made in these pages, some special details of the pier foundations are of sufficient importance to warrant special mention, and Herr Simon, whose plans for this portion of the work were adopted, contributes to the *Schweizerische Bauzeitung* (Feb. 6) an illustrated account of the method of procedure. The bridge is to cross the Aar at a high level, spanning the stream with a single great arch, while the nature of the banks requires that the piers must be built in the steep slope of the bank. This means that they must be carried down through more than fifty feet of packed earth, and then through about twenty-five feet of clayey loam, to a bed of gravel. The character of the work makes it most important that there shall be no movement to either of the piers, since the presence of the wedge of loam under the main bank of earth might cause the whole hillside to slip, were it once set in motion. Bearing this point in mind, it was decided to carry down foundations of such weight and stability as to render this action impossible.

Each pier foundation consists of two elliptical brick caissons, so to speak, the method of construction adopted being somewhat like that used for sinking well linings in India. Instead, however, of building upon the caisson from above, and permitting it to sink by its weight as the earth was excavated beneath, the brickwork was laid in sections from beneath, a shaft being sunk in the center, and then portions of the space under the masonry were successively dug out and replaced with brickwork, until the whole periphery had been completed. In this way the brick shafts have been carried down to the gravel-bed practically as a whole, without previously requiring the dangerous operation of excavating in the earth and clay slope.

The dimensions of each shaft are 20 feet by 11, and there are two shafts to each pier; the completed shafts are filled with concrete, and form each a solid mass of masonry.

It is apparent that this method requires that time must be given for the mortar of one course to harden before under-cutting for the next, and, in fact, forty-eight hours were found sufficient for this purpose, spaces of three to four feet being left unsupported underneath, while the brick-

work was being filled in. The maximum settling observed was in the east shaft, and was only about one inch, which shows that the method was most carefully executed.

A sheet of details accompanies the article, which is well worthy of perusal by engineers in this country.

Boiler Incrustations.

IN connection with the thorough treatment of the subject of corrosion and scale from boiler-waters in Mr. Cary's articles appearing in THE ENGINEERING MAGAZINE for March and April, it is interesting to note some phases of European experience and practice, as reviewed by M. Dibos, in *La Revue Technique* (Jan. 25). After referring to the experiments of Hirsch as to the increase in temperature of the plates caused by deposits of scale of various thicknesses, he discusses the danger of explosion due to the formation of scale, distinguishing between the powdery deposit of carbonate of lime and the hard, crystalline aggregation of sulphate of lime.

According to analyses, which are given in full, more than 75 per cent. of scale deposited from river-water is carbonate of lime, and only about 3 per cent. sulphate, while, for brackish water, the proportions of carbonate and sulphate are nearly equal, being about 40 per cent. each. For sea-water the other extreme is reached; there is more than 85 per cent. of sulphate and less than 1 per cent. of carbonate. The quantity of hydrate of magnesia in none of these cases rises above 4 per cent., but its presence causes the incrustations to become harder and more resistant than they otherwise would be.

M. Dibos describes a remarkable case of strong corrosive action upon the metal underneath the coating of scale, recently investigated at Brest in the boilers of the Oriolle. According to Bertin, this action is caused by a reaction between the chlorid of sodium and silicic hydrate, producing silicate of soda and hydrochloric acid, and also by a reaction between the chlorid of sodium and the silicate of magnesia, giving a silicate of soda and chlorid of magnesium, decomposed in turn by the heat.

Referring to the innumerable remedies which have been proposed, that of heating the feed-water to 150° C. (282° F.) and separating the precipitated sulphate of lime is mentioned, as well as Dulac's system of precipitating the impurities chemically and separating the solid matter before the water is permitted to enter the boiler. Various materials that may be introduced into the boiler to separate the scale-forming constituents are named; the evils of this method are found in the unequal manner in which such reagents act. The portion of scale in immediate contact with the plates is not acted upon, and the softening of a portion only renders frequent cleaning necessary to prevent the loosened scale from collecting elsewhere.

The too common practice of testing a boiler by hydrostatic pressure and assuming it safe without a thorough interior examination is condemned, and a careful inspection every ten or twelve months is recommended.

In concluding, M. Dibos refers to the so-called "antitartrate" solution of Lieut. Bretel, which appears to be an alkaline tannate that has been used with success in the boilers of the *Messageries maritimes*, as well as in vessels belonging to the well-known firm of Cockerill, of Seraing.

The Creep of Rails.

A VALUABLE paper upon the above subject was presented recently before the railway section of the Austrian Society of Engineers, by Inspector von Engerth, and is now printed in full, with diagrams, in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for January 22 and 29. The fact that rails do creep has long been observed, but this shifting of position appears to be a final resultant of so many different causes that its full investigation is voluminous. Inspector v. Engerth has collected data from a number of the continental railways, and from these he studies the problem. Especially is he indebted to M. Coüard of the Paris-Lyons-Mediterranée railway, and to the report of Herr Ast upon Austrian railways.

In most of the roads investigated, the creep was in the direction of the travel of

trains, and also down the grades, as might be expected. The greatest creep observed was that on the Kaiser Ferdinands-Nordbahn, where the maximum was 260 millimeters in one year, but this was exceptional, as on the same road the total creep for seven years was 420 millimeters. The creep, however, takes place on straight, level sections of road, and, furthermore, is not alike for both rails, the left rail almost invariably showing the greater creep.

Careful measurements were made upon about 500 miles of the Austro-Hungarian State railways, of which more than 300 miles are double-track, and data were obtained upon the following points: nature of ballasting, relative level of rails, width of embankments, character of rail-fastenings, length of time in which no creep occurred, and other special points that presented themselves.

M. Coüard, in his investigations, found that in double-track roads the creep was in the direction of train motion, and explains this action as follows:

When the engine wheels approach the end of a rail, the weight of the engine causes the rail to spring down a little lower than the end of the next rail, which has as yet none of the weight upon it. This causes the wheel to strike a blow upon the end of the rail which is being approached, and the horizontal component of this blow acts to drive the rail along in the direction of the motion of the engine. The greater creep of the left rail he explains by the fact that on the Paris-Lyons-Mediterranée road, on which the trains keep to the left, the outer rail, being further away from the center of the road-bed, is not so well supported as the inner rail, and hence suffers greater deflection. For single-track sections, the creep appears to be in the direction of the swiftest trains or the heaviest loads, thus bearing out the same theory.

The investigations in Austria, however, did not altogether support this view. Herr Spitz, who assisted in making the examinations, found that the greater creep of the left rail also appeared on the Hungarian roads, on which the trains keep to the right, the left rail being in the middle portion of the road-bed, showing that some other cause must be found to explain the inequality. Local conditions, such as difference in ramming the ballast, unequal depth, etc., were found to cause unequal creep, and in some instances the creep was less down steep grades than on portions more nearly level.

Herr Spitz, to whom the credit for the second portion of the paper is due, thinks that the true cause of the unequal creep of the rails is the action of the forces in the engines; he contributes an elaborate discussion of the successive impulses tending to produce blows upon the rails. Taking each side separately, he plotted the successive phases, and then, combining them into one diagram, showed the resultant to be in accordance with the observed facts.

It would be interesting to apply the same analysis to the observations made in this country, and thus obtain a confirmation or refutation of this result.

The Development of Telephony.

THE issues of the *Elektrotechnische Zeitschrift* for February 4 and 11 contain a paper read before the Electrotechnic Society of Berlin by Herr West, upon the future development of the telephone, referring principally to Germany, although many of his points are of value and interest elsewhere. After referring to the importance of increased facilities for communication, the author takes up the subject of long-distance telephony, and shows how its use might be greatly extended by a different system of operation. He suggests that the whole country should be divided into sections, each with its own central station or exchange in its largest city, and that then a system of long-distance connections should be arranged between these centers, so that any subscriber in any section could be placed in connection directly with the exchange of any other section and call up any subscriber therein. In this connection he refers to the very great development of telephony in Sweden and in Switzerland, there being in the former country one instrument to every 133 inhabitants in 1894, and in the latter one telephone to every 154 inhabit-

ants, later figures for 1895 bringing Switzerland up to one instrument for every 132 persons.

Great stress is laid upon the necessity of doing away with all ground connections and the introduction of metallic circuits. In connection with the subject of underground conduits, illustrations are given of the clay conduits used in Christiana and Copenhagen, these being shaped like iron channel beams, built up horizontally upon each other.

In the discussion which followed the interesting point was brought out that those countries in which the telephone is most widely used are those in which postal facilities are least developed, and the inference cannot be resisted that possibly a wider extension of telephone facilities might cause a corresponding diminution in postal receipts, and possibly modify altogether existing postal systems, especially if recording-telephony, which was also discussed, be brought to a practical state.

The Action of Stones in Streams.

HERR FERDINAND WANG, professor at the Agricultural High School in Vienna, and royal forest commissioner, has contributed to the *Oesterr. Monatschr. f. d. Oeffentlichen Baudienst* for February a valuable article upon the laws which govern the relations of the water in swift streams to the rocks and stones carried along by the current. This matter is a very important one in the mountain torrents of Switzerland and the Tirol, and, as a mathematical investigation of some of the problems connected with geological erosion, the paper referred to is of significance.

The author considers successively the influence of the presence of loose stones upon the velocity of the water; the impact of the water against the stones, and the resistance of the latter; the limits of the velocity and carrying-power of the water; and the laws which govern erosion, and consequent modification of the profile of the stream.

Although it is not to be expected that rigid laws can be deduced governing a problem in which there are so many variables, yet there are certain general considerations which are of importance.

According to the formula deduced for the velocity of clean water carrying loose stones, it appears that, when the volume of water and stones are equal, the mean velocity is reduced to less than one-half its normal value. The velocity, however, is modified, not only by the mass, but also by the shape of the stones and the manner of their motion, whether singly or in groups. Formulas are given for the impact and resistance of the stones, and from these it is shown that the density of water has a very great influence upon its action in this respect, water saturated with mud, for instance, being much more powerful in its action than pure water.

Water may become saturated, so to speak, with stones and detritus, this saturation depending upon its velocity, much in the same manner as its carrying-power for mud. From this portion of his investigation Herr Wang deduces formulas and laws for the eroding and carrying-power of streams which are of importance in connection with the question of the correction and control of torrents.

Variations in the width of the stream change its velocity, and the material eroded from one place is deposited in another only to change the velocity again and cause new modifications; but for this portion of the subject we must refer the reader to the formulas of the original. An interesting example of the action of the water upon solid bodies is given. During the construction of the Birsig viaduct at Basle a scaffold was overturned, and, among other things, a pillow block, or journal bearing, was lost in the river, and could not be found. Several years afterward it was discovered in excavating for some foundations, more than a thousand feet farther down the stream, buried under ten feet of pebbles!

Improvements in Gas Engines.

AT a recent meeting of the society of German engineers, Herr Petréano gave an account of his improvements in gas engines, by means of which a practically instantaneous explosion is obtained. An

illustrated report is given in the *Zeitschrift des Vereines deutscher Ingenieure* (Feb. 6), from which the following is abstracted.

It has been demonstrated experimentally that the explosion in gas engines of the Otto type is not instantaneous, but continues during the greater portion of the stroke, and that, in fact, unburned gas is discharged with the exhaust. This results in a reduced initial pressure and consequent reduced efficiency, as well as an unnecessary heating of the cylinder, requiring excessive cooling. The coefficients of diffusion of various gases have been determined by Guglielmo, Obermayer, Stefan, Loschmidt, and Waiz, and their results confirmed by Herr Petréano's own experiments, and these show, for example, that 1 liter of marsh gas requires 6 seconds to become fully diffused in 1 liter of air, and that 1 liter of gas compressed with 5 liters of air requires 10 to 12 seconds for diffusion. When, therefore, the time of a single revolution of a gas engine is considered, it will be seen that the mixture cannot become sufficiently intimate to permit proper instaneous explosion.

The apparatus of Herr Petréano provides for the mixture of the air and gas before they enter the cylinder, and consists of a cylindrical chamber through which passes longitudinally a central tube; through this tube the exhaust gases pass, thus heating it to a high temperature. The tube is covered with a wicking of asbestos fiber, and a series of diaphragms are fitted in the annular space between the outside of the central tube and the inside o the chamber. The incoming gas and air pass through this mixing and heating chamber, and are thus thoroughly diffused before they enter the cylinder for compression, and the result, as shown by indicator diagrams, is a greatly-increased rapidity of combustion, and an increase, not only in the initial, but also in the mean effective, pressure.

According to experiments made at the Technical High School at Charlottenburg, it is also possible to avoid altogether the use of circulating water in the jacket, it being only necessary to keep the jacket filled with water, and supply the loss by evaporation. After a ten hours' run under these conditions, the cylinder remained clean, the temperature of the water in the jacket not having exceeded 80° C. (176° F.) The pressure shown by indicator cards for the explosion with the usual construction is only about 2.7 times the pressure of compression, while with the new arrangement the pressure of explosion is shown to be 3.7 times the pressure of compression.

Photographing Rail Deflections.

In an article about the technical applications of photography by Herr Wilhelm Müller, in the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines* for February 5, an arrangement is shown for enabling the deflections of rails, bridges, etc., under moving loads, to be photographically recorded. Briefly, the apparatus consists of a camera of which the plate-holder is fitted to slide across the back by clockwork, so that a series of successive images may be taken upon one and the same plate at uniform intervals of time. The rail or beam to be observed has attached to it a brilliantly-polished bead, which is photographed as a point of light, and the successive images of this point show the deflections. A second lens causes the images of a similar stationary point to be photographed upon the same plate in a line just below, thus furnishing a base line for comparison. The images are so close together that they practically form a continuous line, the deflection images giving an irregular curve showing the movements of the rail, while the spacing of the points upon the base line are clearly enough defined to enable the intervals of time to be noted.

It is, of course, essential that such an apparatus should be mounted upon a very solid foundation, as the least vibration of the camera would be fatal to the accuracy of the record; and the objective used must have great light-gathering power, owing to the feebleness of the illumination. The apparatus as installed in the Nordbahnhofe in Vienna is fixed upon a masonry pier, is fitted with a Zeiss anastigmat objective, and has given excellent results in practice.

Central Condensing Apparatus.

In large establishments, where there are many engines, pumps, compressors, and other steam motors, the idea of installing one central condensing plant has been advocated, all the engines exhausting into one condenser with its independent air and water pumps.

An illustrated description of such a central condensation plant is given by Herr Carl Habermann, in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines* (January 22), and the details are of sufficient interest to warrant presentation here.

The particular plant under consideration is that of the "Ewald" mine, at Herten, where there is a total of over 2,300 h. p. of steam motors, including the large winding engine, air compressors, pumps, etc. The condenser here used is arranged in a separate building from the main engine room, and consists of a system of brass tubes connected by return bends, forming a large box-coil standing in a room. These tubes are cooled by water dripping upon them from above, while a current of air enters from below and passes out above into a sheet-iron stack, thus carrying away the vapor from the room and increasing the rapidity of the evaporation from the outside of the tubes. The water which drips from the tubes falls upon a series of inclined surfaces exposed to the incoming air, and is thus cooled enough to be used again and again, being drawn from the collecting chamber below by a rotary pump and delivered above to the condenser.

The exhaust pipes from the various steam engines all deliver into one large shell, which is connected to the condenser, and in this shell a vacuum is maintained of about 85 per cent. of the atmospheric pressure, or, with the barometer at 30″, about 12.5 pounds.

The air pump is operated by an independent engine, which also drives the circulating pump, and the speed is controlled by a regulator operated by the vacuum, thus keeping the latter quite uniform.

This installation has been in operation for about a year, and has thus far shown an economy of about seventeen per cent. in fuel, enabling two boilers to be dispensed with, besides furnishing pure feed-water and avoiding the formation of scale in the boilers.

The particular apparatus described in the above case is that of Messrs. Balcke & Co., of Bochum; but there are several other makers in Germany, and a list of eleven installations is given, aggregating 32,000 h. p., of which 5,500 h. p. is at Krupp's works at Essen, and 4,000 at the Mannesmann works at Komotau.

The Mining of the Rarer Earths.

The invention of the Welsbach incandescent light has stimulated a search for the materials of which the mantle is composed, and *La Revue Technique* calls attention to the limited supply of some of the materials. At present nearly all the supply of thorite and orangite comes from Norway, and, as a consequence, a mining center has sprung up there. The most active element in the production of the incandescent mantle is the rare metal, thorium, which is found in thorite and orangite to the extent of 50 to 70 per cent., and, as these minerals are not found to any extent elsewhere, Norway has the monopoly. Thorium is also found in monazite, although in a much smaller proportion, and, as this mineral is found not only in Norway, but also in Siberia, Brazil, and North and South Carolina, it forms a secondary source of supply. Since monazite contains the phosphates of cerium, lanthanum, and didymium, as well as thorium, it has been sought to utilize these remaining elements as by-products, in order to reduce the net cost of the thorium.

Up to the present time only the cerium has been used, in the form of oxid, as a coloring material for glass, producing a fine yellow tint. Attempts to use it for coloring ceramics and textile products have not been so successful, but experiments are being continued in the laboratory of the technical high school at Charlottenburg.

So far no practical applications of the didymium and lanthanum have been made, and this field is yet open for the investigation of the technical chemist.

Rapid Transit in Vienna.

THE issues of the *Zeitschrift d. Oesterr. Ing. u. Arch. Vereines* for January 1 and 8 contain a very full account of the new Vienna local railway system from the pen of its director, Herr von Klammstein, with many illustrations of the work.

For a number of years Vienna, like most other large cities, has been seeking rapid transit, but the execution of the work was delayed from various causes, until the present plans were authorized by the enactments of 1892. The system is divided into a main belt line of about 8½ miles in length, encircling the built-up portion of the city, together with local lines connecting this belt line with the various railways approaching the city. A careful study was made of the London underground railway, as well as of the elevated roads in Liverpool, New York, and Chicago, and, as a result, the Vienna road is a combination of both underground and elevated systems. As the road is intended to be operated in connection with the main railways' systems for suburban travel and for summer excursions, the connections with the terminal stations are made at the station level, after which the belt line climbs first to an elevation above the street level, and subsequently passes into a cutting and runs underground, the elevated portion, however, being the most extensive.

The overhead work is much more substantial than that to which New Yorkers are accustomed, much of the road running upon a handsome masonry structure, while wide streets are spanned by single arches of steel or masonry, of artistic design and ornamental construction.

The road is planned at present to be operated by steam, although the subject of converting it ultimately to an electric system has been taken into consideration in its construction. Two forms of cars are used, one being the orthodox European compartment "carriage," and the other the American corridor pattern. The whole structure is an important attempt at the solution of the vexed question of local rapid transit, and the successful operation of the Vienna system will be watched with much interest by other great cities.

Cantilever Constructions.

THE issue of *Glaser's Annalen* for February 1 contains a valuable paper read before the German Railway Society by Professor Reuleaux upon the subject of cantilever constructions in bridges and in buildings. The paper is mainly descriptive in character, and contains numerous illustrations of cantilever bridges, among which may be mentioned those at Frankfurt a.M. at Loschwitz, and especially the new Mirabeau bridge over the Seine at Paris. The latter is a remarkable example of that skilful combination of excellent structural design with artistic effect which the French know so well how to produce. In the hands of American and English engineers the cantilever has been carried to a high degree of structural excellence, but it is almost the unanimous opinion that a cantilever is an uglyaffair, detracting greatly from whatever beauty the surroundings may possess. The Mirabeau bridge, on the contrary, is artistic in appearance, and, in the graceful curves of its main span of 325 feet, it recalls the smaller arches of Ammanati's famous Arno bridge, claimed to be the most beautiful in the world.

Professor Reuleaux also gives illustrations of the Forth bridge, the Verrugas viaduct, the Poughkeepsie bridge, and others well known on this side of the Atlantic, and concludes his paper with a description of some of the details of construction of tall buildings in New York.

Utilization of Power at the Iron Gates.

THE completion of the canalization of the Danube at the Iron Gates, of which an account was given in these columns last month, has given rise to various schemes for the utilization of the power of the water at the various dams. The control of the power is in the hands of the three kingdoms bordering on the river, and already in Hungary a cement and barrel factory, as well as several woodworking establishments, are operated by the power of the river. At present only about 1,000 h. p. are taken off, but it is estimated that about 30,000 h. p. are available, most of which will be transmitted electrically to various points for use.

The Leipzig Memorial.

THE artistic results of competition are not usually very gratifying from an esthetic point of view, possibly from the fact that inspiration cannot be manufactured to order, and doubtless also because the best architects are generally unwilling to enter competitions. This may be the reason why the designs submitted in the competition for the Leipzig memorial are so commonplace. Good half-tone reproductions of the drawings are published in the issues of the *Deutsche Bauzeitung* for January 16, 20, and 23. The location of the proposed monument is excellent, being on a moderate eminence, to be approached by a new avenue giving a fine opportunity for proper display, while surely historic inspiration should not be lacking for a memorial to be placed in the midst of the field of the "battle of the nations" in the year of the "deliverance."

The design which carried off the first prize, and which bore the name "Walküre," resembles an Aztec pyramid flanked by the apse of a Romanesque basilica, upon which is perched one of the battle maidens holding aloft her spear. The second prize was awarded to Herr Rieth, of Berlin; while possessing some effective points, it is but a reproduction of the various details in the battle monuments in other German cities, consisting, as it does, of a colossal seated figure of the orthodox "Germania" with arm aloft and sword in lap. The other designs, seven in all, are disappointing, and it cannot be doubted that more satisfactory results would have been obtained, had the commission been given to some already eminent sculptor, rather than submitted to a competition.

Placed beside such a noble memorial as Thorwaldsen's lion at Lucerne, the monuments proposed for Leipzig hardly seem worthy of more than passing notice as examples of the result of art competitions.

Water Gas in Vienna.

THE water-gas question, which has been pretty well settled on this side of the Atlantic, is agitating Vienna, and an article by Dr. Hugo Strache, in the *Wiener Bauindustrie-Zeitung*, discusses the matter at length. After alluding to the extensive use in the United States of water gas enriched with petroleum, he admits that the higher price of petroleum has been an obstacle to its economical use in Europe. The introduction of incandescent gas burners, however, does away with the necessity of enrichment, and under these new conditions the superior economy of water gas over coal gas is manifest.

The question of the poisonous nature of water gas Dr. Strache does not think of sufficient importance to forbid its use, and he refers to the various methods of insuring freedom from fatal consequences, such as self-closing burners which require to be warmed by the match before the gas can escape, and which close by cooling if the gas should be blown out accidentally. He also suggests the use of spongy platinum to make a self-lighting burner, so that escaping gas would relight the flame and prevent accidents.

In addition to the demand for lighting, the supply of gas for motors is urged, and altogether a very strong case for water gas is made.

The Calibration of Current Meters.

THE February issue of the *Oesterr. Monatschrift d. Offentlichen Baudienst* contains an interesting account of the apparatus used by the Austrian Hydrographic Bureau for calibrating current meters of the Woltmann-Mill type, and determining constants for their rating. The tank is nearly 400 feet long and nearly 6 feet deep, entirely closed in a shed. On each side of the canal is a rail, so that a car carried on the rails runs directly over the canal. This car is propelled by electricity, and its speed can be regulated from about 100 feet per minute up to 1,000 feet. On the car is placed the recording apparatus, consisting of a chronograph, a speed-recorder, and a distance-recorder, all making electric records of the various data.

The current meter makes an electric contact for every fifty revolutions, while the chronograph marks seconds, and the distance is recorded for every ten meters; and, as all these appear side by side on the

same strip of paper, the relations which the revolutions of the meter bear to the elements of time and distance may be fully investigated.

The article referred to gives an example of the calibration of a meter made by the well-known firm of Hipp, of Neuchatel, exhibiting very fully the practical working of the apparatus.

The same article gives a description of Schaffler's "Limnigraph,"—an apparatus for recording the level of water in reservoirs, lakes, and other bodies. This consists of an ingenious combination of a counterbalanced float and a revolving drum, a graphical record being traced, showing the level of the water at any moment.

Electrical Progress in Hungary.

THE Hungarian Millennial has done much to open the eyes of the rest of the world as to the great and rapid progress which that enterprising nation has made in all matters technical, and a report by Dr. Moritz v. Hoor in the *Zeitschrift des Vereines deutscher Ingenieure* (Jan. 30) upon some of the electro-technical features of the exposition shows that Hungary is not behind in applied electricity. Notwithstanding all that we have heard about the success of the underground trolley in Budapest, the trolley tramcars shown at the exposition have the familiar overhead pole, and are in all respects the same as those used here.

Some neat little electric mine locomotives of 4½ tons' weight are also illustrated, these having been used at the exposition on a railway in the grounds, drawing four cars for twenty passengers each.

A handy little portable drilling machine by Ganz & Co. is exhibited. It is suspended to a crane hook, the transmission being through a short shaft with double universal joints. Such drills are extensively used in the machine shops of Hungary. A novel application also was shown in the connection of an electric motor to operate the cable of a captive military balloon, the motor being controlled from the car of the balloon, and also regulated automatically by the speed of the ascent.

Continental Locomotives.

DURING 1896 three exhibitions were held in Europe, at which extensive displays of rolling-stock were made, and in a previous review we have noticed some of the features of the railway exhibits at the Hungarian Millennial.

Herr von Littrow, the chief engineer of the Austrian State railways, contributes to the issue of the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines* (Feb. 5) a review of the engines exhibited at Berlin, Budapest, and Nuremberg, covering details of the twenty-four locomotives shown; and his article is a very complete account of the approved practice of central Europe at the present time. Nine of the engines were compound in principle, and of these four were built with four cylinders, some of them decidedly peculiar in arrangement.

Outside valve gears were used in all cases, the well-known Walschaert form being the favorite, but the Allan and the Stephenson link motions also appeared, while in one engine—a combination rack locomotive on the Abt system—the Joy gear was shown, accompanied, however, by the explanation that it was employed because there was no possible room for eccentrics.

Among the novelties a heavy compound consolidation engine of 65 tons by Krauss, of Munich, was shown, constructed with the high-pressure cylinder sunk into the lid of the low-pressure, and a single-trunk piston operating in both. A single valve admits steam to both cylinders, the exhaust from the high-pressure passing through a passage in the valve to the other end of the low-pressure cylinder, as used by du Bousquet nearly ten years ago, in France. In this engine, however, the low-pressure cylinder is of the annular type, and there is a pair of such cylinders on either side, this being one of the four-cylinder locomotives above referred to.

Another engine of interest, also by Krauss, has a pair of single drivers 1,860 millimeters in diameter, with a pair of auxiliary drivers 1 meter in diameter to assist in starting. This latter pair of wheels has its own engines complete, and is ar-

ranged with a pressure cylinder over the axle, so that the adhesion can be augmented by the amount of the full boiler pressure, thus practically giving what a bicyclist would call a "low gear" for starting, and at the same time dispensing with the objectionable parallel rod. This auxiliary engine is also used to assist in climbing steep grades, or it may be thrown out of service by relieving the pressure on the journals, when the driving-wheels are lifted out of contact with the rails.

A general sheet of illustrations exhibits in skeleton the different types of engines and the leading dimensions are tabulated in a comprehensive manner.

Railways in Hungary.

THE rapid development of Hungary during the past twenty years has almost equalled that of some of our western States, as is evinced by the fact that the population of Budapest has increased from about 300,000 to 600,000 in seventeen years, and the recent celebration, intended to commemorate the thousandth anniversary of the appearance of Arpád and his followers in Europe, was really rather a demonstration of the growth of Hungary in the past generation.

Nothing has been more marked in Hungary than the development of its railway system, and, from a contribution by Edmund Kelényi in *Zeitschr. d. Ver. Deutcher Ing.* for January 9, the following account is condensed.

Apart from the mechanical details of railway operation, the most remarkable showing is that of the success of the "zone" system for railway tariffs.

The great reduction in rates stimulated travel to such an extent that, from 5,047,500 passengers carried by the Hungarian State railways in 1889, the number rose to 15,690,600 in the next year. With this increase in patronage the extension of the lines has increased, the mileage growing 57 per cent. and the number of passengers 108 per cent. between 1890 and 1894. The development of general industry is also well shown by the increase in goods traffic. Formerly about the only merchandise consisted in grain, and the business fluctuated every year with the harvests. In 1867 the total traffic was 3,881,500 metric tons, carried 581,753,400 ton-kilometers (about 361,000,000 ton-miles), while in 1894 it had risen to 27,589,300 metric tons and 3,653,374,500 ton-kilometers (about 2,236,000,000 ton-miles). An interesting feature in this connection also is the fact that, instead of being a source of loss, as they were before the introduction of the zone system, the Hungarian State railways showed a profit in 1894 of 4.92 per cent. on the capital.

Steel rails were introduced in 1870, and in 1895 82 per cent. of the rails in use were of steel; iron sleepers are extensively used.

The principal feature at the millennial exhibition, however, was locomotives, and Herr Kelényi devotes much space to illustrations and descriptions of them. Some of these are only of historical interest, but full detail drawings are given of a 54-ton compound express locomotive. This engine is of the four-cylinder tandem type, with Walschaert valve gear, swivel truck, four driving-wheels 2 meters in diameter, and boiler of the regular American type, intended to carry 185 pounds' pressure. The engine looks much more like an American locomotive than those usually seen on the continent, and is credited with a speed of 90 kilometers an hour.

The locomotives are built at the government shops at Budapest, the works having a capacity of one hundred and ninety engines a year, and the various types shown give evidence that the establishment is up to date.

Electric Traction in Versailles.

THE trolley still continues to make its inroads into France, and that in places where it might least be expected. The hitherto quiet and almost sleepy town of Versailles has been awakened, and the completion of a belt system of electric tramways has made travel easy and rapid. It is interesting to note that the American system of the General Electric Company, having overhead wires, is used, and, altogether, the former retreat of the Grand Monarque has become considerably Americanized.

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North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6d. London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1 New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *w.* 58 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

BRICK.

Use and Advantage of Hollow Brick. J. M. Mamer. Sets forth many advantages, and discusses means of introducing; gives results of tests and brief discussion. 2,500 w. Brick—Feb., 1897. No. 11,043. 15 cts.

BRISTOL.

The Architecture of Bristol, Eng. Illustrated description. 6,500 w. Builder—Jan. 30, 1897. No. 10,979. 30 cts.

CATHEDRAL.

Ely Cathedral. A paper prepared by the late Sir Gilbert Scott, in which the origin of the different parts of the building is described and their architectural value determined. Ill. 2,500 w. Arch, Lond.—Jan. 29, 1897. Serial. 1st part. No. 10,977. 30 cts.

CHURCHES.

Protestant Church Buildings. (Der Protestantische Kirchenbau.) An illustrated historical description of the development of protestant church buildings, mainly in Germany. 8,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,442. 30 cts.

CLAY.

Clay in Architecture. Henry R. Griffen. Discusses the changes within the past few years in the use of clay in architectural work; and the tendency of the times. Read at Nat. Brick Mfrs.' Assn. and followed by discussion. 5,400 w. Brick—Feb., 1897. No. 11,045. 15 cts.

DECORATION.

The Decorations in the New Congressional Library. William A. Coffin. Illustrated description of the interior decorations. 7,500 w. Century Mag—March, 1897. No. 11,231. 45 cts.

DESIGN.

Principles of Design. W. A. Langton. Read at the annual convention of the Ontario Assn. of Archts. A study of rules and principles that may be a guide in matters of taste. Followed by discussion. 4,800 w. Can Archt—Feb., 1897. No. 11,143. 30 cts.

FIREPROOF Construction.

Materials and Methods in Fireproof Construction. W. M. Scanlan. The writer names the forms of construction and the materials that seem to him the best. Of materials, porous tiling is considered the best, and the beam floor construction. 4,300 w. Eng Mag—March, 1897. No. 11,336. 30 cts.

FOUNDATIONS.

Field Engineering Abroad. Condensed selections from papers by Sir Guilford Molesworth, with illustrations prepared from copies of original photographs. Part first treats of heavy foundations in loose and alluvial soil. 2,400 w. Eng Rec—Feb. 20, 1897. Serial. 1st part. No. 11,148. 15 cts.

GYMNASIUM.

Gymnasium at Podgórze, near Cracow. (Turnhalle des Turnvereines "Sokol" in Podgórze vei Krakau.) Plate and brief description of a fine gymnasium hall, also arranged for theatrical performances, &c. 300 w. 1 plate. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,441. 30 cts.

HOSPITAL.

Hospital for Chest Diseases at Davos. (Die Basler Heilstätte für Brustkranke in Davos.) Plans, elevation and description of special cantonal hospital of 70 beds, near Basle, Switzerland. 3,000 w. Schweizerische Bauzeitung—Jan. 30, 1897. No. 11,446. 15 cts.

LABORERS' Houses.

The Housing of the Laboring Classes Problem. Percy Boulnois. Some comments on the latest developments in England. 1,500 w. San Rec—Feb. 19, 1897. No. 11,309. 30 cts.

LIBRARY.

The Nation's Library. A. R. Spofford. Illustrated description of the new building and special features of the Congressional Library, as given by the Librarian. 4,500 w. Century Mag—March, 1897. No. 11,230. 45 cts.

TEMPLE.

The Temple of the Malatesta at Rimini. Description taken from an article by Miss Robinson in the English Illustrated Magazine. 1,800 w. Am Arch—Feb. 20, 1897. No. 11,191. 15 cts.

HEATING AND VENTILATION.

HOSPITAL.

Ventilation of a Detroit Hospital. Illustrated description of a heating and ventilating plant designed and installed by the Am. Blower Co. of Detroit. 1,300 w. Eng Rec—Feb. 20, 1897. No. 11,152. 15 cts.

HOT Water.

Heating Buildings by Hot Water. F. Dye. It is proposed to give a complete account of the not water engineer's work in heating buildings, and this will include a full description of the newest English and American methods and systems. Part first explains action of heat and cause of circulating movement. 2,000 w. Plumb & Dec—Feb. 1, 1897. No. 11,089. 30 cts.

STEAM Heating.

Circulation of Steam for Heating Purposes at or Below the Pressure of the Atmosphere. Reginald Pelham Bolton. A study of the difficulties and limitations, with description of improved apparatus. Followed by discussion. 7,000 w. Heat & Ven—Feb. 15, 1897. No. 11,133. 15 cts.

VENTILATION.

Relative Efficiency of Ventilation by a Chimney and by a Fan. R. C. Carpenter. Determined by circulation and by reference to experiments made relating to effi-

ciency of fans and engines. 2,800 w. Heat & Ven—Feb. 15, 1897. No. 11,134. 15 cts.

LANDSCAPE GARDENING.

GARDEN.

The Garden in Relation to the House. H. E. Milner. Read at meeting of Royal Inst. of Brit. Archts. Discusses the treatment to be adopted in laying out grounds, particularly in their relation to the house. Discussion follows. 3,500 w. Builder—Feb. 20, 1897. No. 11,279. 30 cts.

PLUMBING AND GASFITTING.

PIPE.

Lead Pipe vs. Iron Pipe. William Eccles. Compares the several advantages of lead and galvanized iron pipe when used for water supply and vent pipes. 1,000 w. Dom Engng—Feb., 1897. No. 11,106. 30 cts.

PLUMBING.

Law and Bad Plumbing. Some account of the work done by Mr. H. A. Desper, of Worcester, Mass., to show the effect of bad plumbing on health and so influence legislation to provide for the examination of plumbers, and the control of this work. Ill. 6,400 w. Met Work—Feb. 20, 1897. No. 11,142. 15 cts.

Plumbing in the St. Paul Building, New York. Part first contains general description and arrangement, diagram of risers, pipe systems, materials, waste, vent and supply lines, and pressure test. 2,400 w. Eng Rec—Feb. 13, 1897. No. 11,020. 15 cts.

MISCELLANY.

ARCHITECTURAL History.

An Unwritten Chapter of English Architectural History. A. S. Flower. Results of independent research into the history and characteristics of the Mediaeval architecture of England. 5,500 w. Arch, Lond—Feb. 12, 1897. No. 11,193. 30 cts.

ARCHITECTURE.

Is Architecture a Living Art? Peter B. Wight. First of a series of papers discussing two questions—"Is Architecture a Living Art?" and "Can Architecture Again Become a Living Art?" read before the Illinois Chapter of the Amer. Inst. of Archs. 6,500 w. In Arch—Feb., 1897. Serial. 1st part. No. 11,098. $1.00.

DE TRESGUERRAS.

A Great Mexican Architect. Sylvester Baxter. Francisco Eduardo de Tresquerras and his work. Part first states the architectural conditions of Mexico in this architect's time. 1,800 w. Am Arch—Feb. 13, 1897. Serial. 1st part. No. 11,050. 15 cts.

MASONS.

Criticism on "Code of Practice of the Chicago Masons' and Builders' Association." Dankmar Adler. An open letter to Chicago mason builders with a copy of code. 3,300 w. In Arch—Feb., 1897. No. 11,097. $1.00.

MONASTERIES.

The Meteora Monasteries in Thessaly. Herman Hirsch. Illustrated description of the strange location and the peculiarities of the landscape. From Ueber Land and Meer. 1,000 w. Sci Am Sup—Feb. 27, 1897. No. 11,212. 15 cts.

PADUA.

Italian Cities; Padua. H. Mereu. Interesting information concerning the architecture and arts of this city. 1,800 w. Am Arch—Feb. 27, 1897. No. 11,246. 15 cts.

SCULPTURE.

Sculptors and Architecture. Brief review of the work of sculptors as connected with architecture, explaining the connection of Phidias with the Parthenon, the work of Brunelleschi in constructing the dome of Santa Maria del Fiore, in Florence, &c. 2,800 w. Arch, Lond—Feb. 12, 1897. No. 11,192. 30 cts.

The Sculptor's Architecture of the Renaissance. Alfred Gilbert. Read at meeting of Roy. Inst. of Brit. Archt's. A short but interesting paper on the work of the sculptor-architect; followed by discussion. 1,600 w. Arch, Lond—Feb. 5, 1897. No. 11,070. 30 cts.

STAINED Glass.

Stained Glass as a Modern Art. Reviews a recent book, "Stained Glass as an Art," by Henry Holiday. The changes being wrought by the study of the figure as the leading element in stained glass design. 3,000 w. Builder—Feb. 13, 1897. No. 11,185. 30 cts.

CIVIL ENGINEERING.

BRIDGES.

ACCIDENTS.

Bridge Accidents in the United States and Canada in 1896. Charles F. Stowell. Tabular statements are presented, with explanatory remarks. 1,400 w. Eng News—Feb. 11, 1897. No. 11,018. 15 cts.

BRIDGES.

See same title under Railroad Affairs, Maintenance of Way and Structures.

CANTILEVER.

Cantilevers in Bridge and Building Construction. (Freiträger im Brücken-und Hochbau.) A paper read before the German Railway Society by Prof. Reuleaux, with many illustrations of European and American practice. 8,000 w. Glaser's Annalen—Feb. 1, 1897. No. 11,418. 30 cts.

DRAWBRIDGE.

See Railroad Affairs, Way and Structures.

FOUNDATIONS.

Pier Foundations of the Kornhaus Bridge at Bern. (Kornhausbrücke in Bern Fundierung des Schüttehaldepfeilers.) An account of the sinking of the foundations for the great arch over the Aar. The foundations had to be carried

through sloping banks of earth and loam to deep gravel below. 2,500 w. 1 plate. Schweizerische Banzeitung—Feb. 6, 1897. No. 11,447. 15 cts.

PLATE Girder.

Best Method of Erecting Plate Girder Bridges. Discussion of committee report at convention of the Assn. of Ry. Supts. of Bridges and Buildings. Ill. 1,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,057. 45 cts.

A New Formula for So Locating Two Plate Girders Relative to a Curve as to Bring Equal Loads to Each. Henry Szlapka. Applies, strictly speaking, to plate girders without a cover plate only, but is a very close approximation also in case of girders with plates. 250 w. Eng News—March 4, 1897. No. 11,356. 15 cts.

RHINE.

Proposed Bridge Over the Rhine at Worms. (Der Wettbewerb um den Entwurf einer festen Strassenbrücke über den Rhein bei Worms.) A description, with details, of a three-span stiffened suspension truss bridge, with spans of 350 feet. Two articles. 12,000 w. Zeitschr. d. Vereines Deutscher Ing—Jan. 16 and 23, 1897. No. 11,401. 45 cts.

STEEL.

Steel Road Bridge, 150 Feet Clear Span. Illustration of the general design and some details of a steel road bridge lately supplied to the Travancore Government. 450 w. Ind Engng—Jan. 9, 1897. No. 11,032. 45 cts.

STONE.

The Historical Development of Stone Bridges. George F. Swain. Lecture delivered before the Assn. of Engng. Soc. Traces the history from the earliest times and the progress by different nations. Illustrated. 5,700 w. Stone—Feb., 1897. No. 11,138. 30 cts.

TIMBER.

Strength of Various Kinds of Timber Used in Trestles and Bridges. Especially with Reference to Southern Yellow Pine, White Pine, Fir and Oak. Discussion of committee report at the convention of the Assn. of Ry. Supts. of Bridges and Buildings. 1,600 w. Pro of Assn. of Ry Supts—Oct., 1896. No. 11,056. 45 cts.

VIADUCT Disaster.

See same subject under Railroad Affairs, Way and Structures.

CANALS, RIVERS AND HARBORS.

CANALS.

New York's Canals. Campbell W. Adams. An exhaustive but not too technical discussion of the work under the nine-million dollar canal improvement bill. States opposition to a ship canal and benefits to follow present improvement of free canals. Also editorial. 6,000 w. Sea—March 4, 1897. No. 11,245. 15 cts.

DAM.

Bear-Trap Dam — Chicago Drainage Canal. Illustrated detailed description. 1,300 w. R R Gaz—Feb. 12, 1897. No. 11,013. 15 cts.

DISMAL SWAMP.

The Dismal Swamp Canal. J. Clinton Ranson. Account of a new traffic route between the North and South. 2,200 w. Tradesman—March 1, 1897. No. 11,305. 15 cts.

FLOODS.

The Seasons and Causes of Western River Floods. James L. Greenleaf. Showing the conditions that govern the rise and fall of Western rivers. Ill. 4,500 w. Eng Mag—March, 1897. No. 11,340. 30 cts.

NEW YORK.

New York Harbor. Some account of the marked features of the harbor, the amount of trade and the great number of vessels, both for marine and inland navigation, which visit the wharves. 1,500 w. Sea—Feb. 18, 1897. No. 11,141. 15 cts.

RIVER FLUSHING.

See "Tunnel," under Municipal Engng., Sewerage.

WATERWAYS.

The Report of the United States Deep Waterways Commission. Extracts from the report bearing on the feasibility of the canal as a commercial enterprise, and some conclusions as to the merits of proposed routes. Also editorial comment. 12,000 w. Eng News—Feb. 11, 1897. No. 11,017. 15 cts.

HYDRAULICS.

DEBRIS.

The Laws of the Motion of Debris (Die Gesetze der Bewegung des Geschiebes.) A valuable discussion of the motion of stones and debris in mountain torrents, with investigation as to the erosion and modification of channel profiles. 7,500 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst. Feb., 1897. No. 11,443. 30 cts.

HYDROGRAPHY.

Hydrographic Service of Austria in 1896. (Der hydrographische Dienst Oesterreichs im Jahre 1896.) Report of the Austrian hydrographic bureau, with illustrated description of tank for testing current meters. 4 plates. 4,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,440. 30 cts.

RAINFALL.

Cloudburst in Southern Dalmatia, Nov. 8 and 9, 1896. (Der Wolkenbruch am 8 und 9 November, 1896, in Süd. Dalmatien.) Report of the hydrographic bureau upon the meteorological conditions accompanying the hurricane and extraordinary rainfall of above date, 234.4 mm.=9.2 ins. of rain, fell in 24 hours. 2,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,444. 30 cts.

IRRIGATION.

CANAL.

The Nira Irrigation Canal. Describes one of the large works designed for famine-relief purposes. Maps and sections.

2,000 w. Eng, Lond—Feb. 5, 1897. Serial. 1st part. No. 11,029. 30 cts.

PUBLIC Lands.

The Arid Public Lands, Their Reclamation, Management and Disposal. Elwood Mead. The inefficiency of the existing public land system is shown and the evils resulting from it. Discussion follows. 17,500 w. Trans Am Soc of Irr Eng—Jan., 1897. No. 11,054. 45 cts.

MISCELLANY.

CEMENT.

The Annual Meeting of the Association of German Portland Cement Manufacturers. S. B. Newburry. An account of the annual meeting, with reports of committees, abstracts of papers, &c. 5,000 w. Eng News—Feb. 25, 1897. No. 11,238. 15 cts.

The Behavior of Portland Cement in Sea Water. Dr. William Michael's. From proceedings of the Inst. of Civ. Engs. Vol. CVII. Describes researches of the writer. 2,500 w. Eng Rec—Feb. 20, 1897. No. 11,149. 15 cts.

CONCRETE.

Notes on Portland Cement, Concrete. Andreas Lundteigen. Tests and favorable results from the admixture of silicious material. 1,600 w. Pro Am Soc of Civ Engs—Feb., 1897. No. 11,234. 45 cts.

DEFLECTIONS.

Technical Applications of Photography. (Ueber die Anwendung der Photographie für technische Zwecke.) Special appliance for photographing rail and bridge deflections; also photogrammetric apparatus, for photographic surveying. 1,200 w. Zeitschr d Oesterr Ing u Arch-Vereines—Feb. 5, 1897. No. 11,427. 15 cts.

EDUCATION.

Engineering Education. (Zur Frage der Ingeineurerziehung. Prof. O. Mohr.) A discussion of the present methods of engineering education in Germany, suggesting simplification of the existing courses in order to provide time and opportunity for study of new subjects. 3,000 w. Zeitchr d Vereines Deutcher Ingenieure—Jan. 23, 1897. No. 11,403. 30 cts.

FILL.

The Compressibility of Salt Marsh Under the Weight of Earth Fill. Eugene R. Smith. Tables of information obtained by the writer from investigations of reclaimed marsh land on the north shore of Great South Bay, at Islip, N. Y. The work is briefly described. 1,100 w. Pro Am Soc of Civ Engs—Feb., 1897. No. 11,233. 45 cts.

JAPAN.

Engineering Works in Japan During 1896. C. Kardono. Does not encourage American contractors to come to Japan on account of their ignorance of customs and usages of the country in contract works. Information of recent improvements. 800 w. Eng News—Feb. 25, 1897. No. 11,239. 15 cts.

SURVEYING.

Experiences with the Contract System of U. S. Land Surveys in Florida. J. Francis Le Baron. Shows the folly of letting to the lowest bidder a class of work that requires ability. Also editorial. 3,500 w. Eng News—Feb. 18, 1897. No. 11,129. 15 cts.

TUNNEL.

The Design and Construction of a Small Steel Cylindrical Tunnel. See same title under Municipal Engng—Sewerage.

The Roof Shield in the Boston Subway. Describes a novel development of shield tunneling as used in the Boston subway. It consists in cutting the shield in two and using the upper half only. Ill. 2,000 w. R R Gaz—Feb. 12, 1897. No. 11,012. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BICYCLE.

American Bicycles in Germany. A statement of the methods necessary to secure a share of the trade. 1,200 w. Cons Repts—Feb., 1897. No. 11,041. 45 cts.

Bicycle Trade in Italy. Discusses the prospect for opening a large export trade in American bicycles. Thinks it favorable and gives reasons. 1,500 w. Cons Repts —March, 1897. No. 11,227. 45 cts.

ELECTRICAL Exports.

American Exportation of Electrical Machinery. Georg Kirkegaard. Calling attention to the market of Northern Europe, and Americans' chances to compete. 600 w. Elec Wld—Feb. 13, 1897. No. 11,036. 15 cts.

GOLD Traffic.

See same title under Mining and Metallurgy, Gold and Silver.

GREAT BRITAIN.

British and Foreign Trade. Extract from memorandum issued by Sir Courteray Boyle, relating to the trade of the United Kingdom in recent years compared with France, Germany and the United States. Deals with population, industry and commerce. 4,000 w. Col Guard—Feb. 5, 1897. No. 11,074. 30 cts.

Foreign Competition and English Railway Rates. Abstract of lecture by Mr. Balfour Browne. The serious and increasing competition is discssed and suggestions made for remedying the trouble, especially the methods for exporting, regulation of railway rates, &c. 3,500 w. Ir & Coal Trds Rev—Feb. 12, 1897. No. 11,201. 30 cts.

Is England's Industrial Supremacy a Myth? S. N. D. North. An analysis of the industrial development of England and Germany, showing that nations may flourish under a protective system and

decline under free trade. 5,000 w. Forum—March, 1897. No. 11,286. 30 cts.

IRON Trade.

An International Comparison of Iron and Steel Exports in 1896. Compares the exports from Great Britain with Germany, France and Belgium. Shows that Great Britain has succeeded in improving her position. 2,200 w. Ir & Coal Trds Rev—Feb. 19, 1897. No. 11,281. 30 cts.

JAPAN.

Foreign Trade of Japan. A somewhat detailed examination of its exports and imports, with information relating to cotton spinning and weaving, the supply of raw cotton, manufacture of silk and the rug and matting industries. 18,000 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,175. 45 cts.

Japanese Industries. Information regarding the manufacture of matches, paper, lacquer, porcelain and glassware; also products of forest, farm and sea. 9,500 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,177. 45 cts.

The Commerce and Industries of Japan. Includes a general account of the location of the principal industries, industrial ambitions, population, occupations and wages, with introductory remarks. 7,200 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,172. 45 cts.

JOINT Stock Companies.

The Economics of Joint Stock Companies and the Laws Relating to Their Incorporation. J. Bawden. Examines the system now in general use in Ontario and British Columbia for converting into cash the stock of mining companies, calling attention to amendments required. Discussion follows. 9,500 w. Can Min Rev—Feb., 1897. No. 11,328. 30 cts.

KOREA.

Trade Prospects in Korea. Editorial discussion of the conditions of the country since the war as gleaned from various reports, and the movements which promise to advance trade interests in the future. 1,500 w. Engng—Feb. 12, 1897. No. 11,164. 30 cts.

MANUFACTURERS.

Annual Report of the President of the National Association of Manufacturers. Records the progress of the work of the Association. Reports on So. Amer. commission, sample warehouses, trade with Mexico, Japan, China, discusses the Nicaragua Canal, merchant marine, tariff, &c., &c. 12,500 w. Circular of Information—No. 13. Feb. 1, 1897. No. 11,072. 45 cts.

PIG-IRON Trade.

See same title under Mining and Metallurgy—Iron and Steel.

RUSSIA.

Agricultural Machinery in Russia. A statement of the conditions existing in Russia in reference to agriculture and manufactures, and the opportunities for trade in machinery and implements. 1,300 w. Bd of Trd Jour—Feb., 1897. No. 11,293. 30 cts.

TARIFF.

Customs Tariff and Regulations of the German Southwest African Protectorate. Translation of a customs ordinance with executive regulations, and the customs tariff. 3,800 w. Bd of Trd Jour—Feb., 1897. No. 11,296. 30 cts.

New Customs Tariff of Brazil. A statement of the duties liable under the new customs tariff in cotton, wool, flax and jute, and manufactures thereof. 4,500 w. Bd of Trd Jour—March, 1897. No. 11,297. 30 cts.

Tariff Changes and Customs Regulations. Denmark, Netherlands, Germany, France, Madagascar, Portugal, Spain, Egypt, United States, Costa Rica, Ecuador, Argentina, Chile, British India, Grenada and Tasmania. 3,000 w. Bd of Trd Jour—March, 1897. No. 11,298. 30 cts.

UNITED STATES.

The Concentration of Industry and Machinery in the United States. E. Levasseur. Extract from one of the chapters of a work now in press. Directs attention to the part which the spirit of invention and the characteristics of the laboring classes have taken in this development, and considers the attitude of the laboring classes and of the entrepreneur to the problems which this transformation has called forth. 6,000 w. An Am Acad—March, 1897. No. 11,290. $1.00.

CURRENCY AND FINANCE.

BIMETALLISM.

Obstacles to International Bimetallism—I. Can the Gresham Law be Circumvented? Jerome Dowd. II. Some of the Obstacles to International Bimetallism. Mark B. Dunnell. Two articles strongly favoring monometallism. 4,000 w. Bankers' Mag., N. Y.—Feb., 1897. No. 11,108. 45 cts.

CURRENCY.

Further Considerations of Our Currency Problem—Charles T. Haviland. Considers the paper currency and the gold reserve, the Baltimore currency plan, menace of the legal tender notes, prejudice against the National banks, suggestions for a bank currency, taking the government out of the banking business, and what to do with the silver in the Treasury. 5,000 w. Bankers' Mag., N. Y.—Feb., 1897. No. 11,109. 45 cts.

The Quantity Theory—W. A. Scott. An inquiry into the nature and soundness of this theory. The writer thinks that the level prices and the volume of currency are not determined by the same influences. 6,000 w. An Am. Acad.—March, 1897. No. 11.292. $1.00.

FINANCIAL Legislation.

The Financial Measures Needful to Industrial Stability. James H. Eckels.

Favoring abandonment of note-issuing by the government, and modification of the Sub-Treasury system. 2,600 w. Eng. Mag.—March, 1897. No. 11,335. 30 cts.

FREE Coinage.

Silver Free Coinage and the Legal Tender Decisions. C. G. Tiedeman. Calls attention to the difficulties which would have been encountered in securing from the Supreme Court of the United States a declaration that a silver free coinage bill was unconstitutional. 4,500 w. An Am. Acad.—March, 1897. No. 11,291. $1.00.

LABOR.

CO-OPERATION.

Co-operative Contracts and Capital. Editorial discussion of the limitation of co-operation. 2,500 w. Engng—Feb. 12, 1897. No. 11,162. 30 cts.

DWELLINGS.

See title LABORERS HOUSES, under Architecture, Construction and Design.

EDUCATION.

The Education of German Mechanics. Editorial discussion of the lessons to be learned from German methods, and particularly from her educational system. 2,500 w. Engng—Feb. 12, 1897. No. 11,163. 30 cts.

JAPAN.

Some Considerations Affecting Japanese Labor. Statements regarding the expense of living, wages and habits of life. 3,300 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,178. 45 cts.

PRISON Labor.

Prison Labor. Carroll D. Wright. The various sides of the question are presented and the economic side shown to be of little importance. By giving more attention to the ethical side of the question, the writer thinks the best results will be reached. 3,800 w. N Am Rev—March, 1897. No. 11,282. 45 cts.

WAGES.

Wages in New York's Industries. Average wages in thirty industries as reported by the State Bureau of Statistics of Labor. 800 w. Bradstreet's—Feb. 13, 1897. No. 11,009. 15 cts.

MISCELLANY.

COMBINATIONS.

The Good and the Evil of Industrial Combination. Arthur Twining Hadley. Discusses the benefits and defects from various points of view. 6,000 w. Atlantic M—March, 1897. No. 11,171. 45 cts.

CORPORATIONS.

How to Reform Business Corporations. V. H. Lockwood. The necessity of corporations and the methods of preventing the mismanagement are discussed, with the difficult problems that must be solved. 3,500 w. N Am Rev—March, 1897. No. 11,283. 45 cts.

EXPOSITION.

The Paris Exposition of 1900. A report on the coming international exposition, setting forth its general scope and character, its organization, the financial arrangements, the special features, systems of classification and awards adopted, and regulations affecting foreign exhibitors. 6,500 w. Cons Repts—Feb., 1897. No. 10,974. 45 cts.

GREAT BRITAIN.

Progress of the British Colonial Empire During the Sixty Years of Her Majesty's Reign. Charles W. Dilke. Historical survey of the colonies, followed by discussion. 14,000 w. Jour Soc of Arts—Feb. 12, 1897. No. 11,179. 30 cts.

HARD Times.

What Are Normal Times? E. V. Smalley. Discusses what normal times really are, and shows that conditions have changed and that it is useless to look for a restoration of the abnormal conditions existing between 1880 and 1890. 2,000 w. Forum—March, 1897. No. 11,285. 30 cts.

IRELAND.

Recommendations of the Recess Committee for the Development of Ireland's Agricultural and Industrial Resources. Horace Plunkett. States the circumstances under which the Recess Committee was formed, its work, effect of past action, Ireland's resources, &c., with discussion. 12,000 w. Jour Soc of Arts—Feb. 5, 1897. No. 11,048. 30 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY AND METALLURGY.

ALUMINUM.

The Bradley Aluminum Patents. The invention relates to a process of effecting by the electric current the separation of aluminum from its ores or compounds. Specifications and drawings. 1,500 w. Eng & Min Jour—Feb. 27, 1897. No. 11,248. 15 cts.

CARBORUNDUM.

Details of the Carborundum Furnace and Its Operation. Illustrated detailed description. 1,200 w. Elec Eng—Feb. 24, 1897. No. 11,205. 15 cts.

LIGHTING.

ALTERNATING Current Arc.

Luminous Efficiency of the Alternating Current Arc. A. E. Blondel, assisted by E. Jigouzo. Extract from a forthcoming publication upon the efficiency of the electric arc. Sets forth the first results of a study of the alternating current arc. 1,800 w. Elec Wld—Feb. 13, 1897. Serial. 1st part. No. 11,038. 15 cts.

CONDUITS.

Interior Conduits. Replies received from manufacturers and engineers in response to a circular letter inquiring for opinions in regard to methods permitting the greatest economy consistent with safety. 3,700

w. Elec Wld—Feb. 27, 1897. No. 11,259. 15 cts.

GAS and Electricity.

See Electricity, under Municipal Engineering, Gas.

INCANDESCENT.

Conductivity of Incandescent Carbon Filaments and the Space Surrounding Them. Abstract of paper by John W. Howell, presented at meeting of Am. Inst. of Elec. Eng., with editorial comment. The paper considers the reversal in the temperature coefficient, and demonstrates that such reversal becomes more prominent as the treatment of the filament is increased. 3,000 w. Elec Wld—Feb. 20, 1897. No. 11,187. 15 cts.

Incandescent Lamps. (Zur Glühlampenfrage.) A discussion of the tests of incandescent lamps at Hanover, from the lamp manufacturer's standpoint. 3,000 w. Elektrotechnische Zeitschr—Jan. 28, 1897. No. 11,433. 15 cts.

INSULATION.

The Insulation Resistance of an Electric Installation. Explains the theory of insulation testing. 2,000 w. Builder—Feb. 20, 1897. No. 11,278. 30 cts.

MUNICIPAL Plants.

The Agitation for Municipal Plants. A series of short articles giving a collection of data bearing on municipal electric light plants, with editorial. 11,500 w. Elec Eng—Feb. 17, 1897. No. 11,096. 15 cts.

Report to the Special Investigating Committee on Commercial Electric Lighting, South Norwalk, Conn. A. E. Winchester. A favorable report of the success of various municipal plants. 10,500 w. Elec Eng—Feb. 17, 1897. No. 11,095. 15 cts.

PROJECTORS.

Projectors. W. H. Pretty. Part first discusses reflectors and lamps. A study of the optical arrangements suited for the purpose of transmitting the light given out by the electrical lamp. 1,400 w. Elect'n—Feb. 19, 1897. Serial. 1st part. No. 11,273. 30 cts.

PUBLIC Buildings.

The Lighting of Public Buildings. H. W. Handcock and A. H. Dykes. Calling attention to the need of installing electric lighting in a more permanent way, if it is to give satisfaction. 2,000 w. Elec Eng, Lond—Feb. 19, 1897. No. 11,311. 30 cts.

SAFETY Devices.

Safety Devices for Electrical Circuits. W. M. Stine. Gives attention to certain mechanical safety devices, as well as fuse wires, and gives results of investigations. 3,300 w. W Elec—Feb. 20, 1897. No. 11,145. 15 cts.

SEARCH Light.

Latest Types of General Electric Search Lights. Illustrated description. 900 w. Elec Eng—Feb. 24, 1897. No. 11,207. 15 cts.

TESTING.

Faults and How to Find Them. Attention is confined to the faults that are common to the various classes of arc lamps. 2,200 w. Am Elect'n—Feb., 1897. No. 11,225. 15 cts.

VOLTAGE.

Electricity Supply at 230 Volts. Alfred H. Gibbings. Presents the results of a wholesale changes of pressure at Bradford The subject is considered in detail. Part first dealing with house terminal fuse boxes, meters, wirings and fittings. 2,400 w. Elec—Feb. 17, 1897. No. 11,099. 15 cts.

WIRING.

Inconsistencies in Electric Wiring. Harry N. Gardner. Calls attention to little inconsistencies which detract from the advantages which would result from carefully installed electric systems and urges the giving of electrical work to only reliable contractors. 2,000 w. Elec Eng—Feb. 24, 1897. No. 11,206. 15 cts.

Interior Wiring. George T. Hanchett. Calls attention to the important details wherein alternate current wiring differs from direct current wiring. 1,800 w. Am Elect'n—Feb., 1897. No. 11,224. 15 cts.

POWER.

AIR and Electricity.

See Electric Power under Mechanical Engineering, Compressed Air.

ALTERNATING Current.

Method of Determining the Number of Alterations (Ueber eine Methode zur Bestimmung der Wechselzahl oscillirender Ströme.) A mathematical discussion by Gustav Wilhelm Meyer. 3,000 w. Elektrotechnische Zeitschrift—Jan. 28, 1897. No. 11,434. 15 cts.

ARMOUR Institute.

Power Plant of Armour Institute of Technology. Illustrated description of the new equipment made necessary by the increased demands for lighting and motor service. 1,000 w. W Elec—Feb. 27, 1897. No. 11,235. 15 cts.

CONVERTERS.

Rotary Converters. Ernst Julius Berg. Their action and the conditions under which their use is desirable, and the reaction of these machines on the alternating system, their methods of operation and the limitations imposed by their use. 2,300 m. Am Elect'n—Feb., 1897. No. 11,216. 15 cts.

DYNAMO.

Dynamo Characteristics.—Wilbur M. Stine. Showing that the characteristic occupies the same practical relation to the dynamo that the indicator does to the steam engine, and gives directions that will enable any one in charge of a dynamo, who possesses a good voltmeter and ammeter, to correctly lay down the several curves of his machine. 1,400 w. Am Elect'n—Feb., 1897. No. 11,220. 15 cts.

Westinghouse Dynamos. (Machines, Dynamo-électriques de la Compagnie Electrique "Westinghouse.") An extended description of the Westinghouse gen-

erators and motors from a French point of view. 12,000 w. La Revue Technique Feb. 10, 1897. No. 11,412. 30 cts.

EFFICIENCY.

The Efficiency of Direct Current Dynamos and Motors. Explanation of the terms employed, with table giving equivalent volts for efficiencies ranging from 60 to 95 per cent. 1,600 w. Elec, Lond—Jan. 29, 1897. No. 11,025. 30 cts.

EMERGENCIES.

An Interesting Example of Practical Expedients. Illustrated description of the rapid and interesting work in re-establishing the service of the Newark, N. J., electric light and power station after the fire. 1,700 w. Am Elect'n—Feb., 1897. No. 11,215. 15 cts.

FARM.

Electricity on a Farm. Brief illustrated description of the utility and advantages of electricity in farm and dairy operations as used on the dairy farm of Mr. Levi P. Morton. 1,000 w. Elec Wld—Feb. 6, 1897. No. 10,972. 15 cts.

GAS Engine.

The Gas Engine for Electrical Purposes. See Gas Engine, under Mechanical Eng'ng—Engines and Motors.

GENERATOR.

Tests of 200-Kilowatt Continuous Current Parsons Turbo-Generator. W. D. Hunter. Describes a series of tests for the purpose of determining the steam consumption under different conditions of service and various grades of output. 400 w. Elec Rev, Lond—Feb. 19, 1897. No. 11,275. 30 cts.

INDICATOR.

A New Frequency Indicator. Account of an instrument invented by G. W. Meyer, for indicating the frequency of oscillating currents, depending on the fact that the heat generated in a wire magnetized by these currents is proportional to their frequency. 800 w. Elec Rev, Lond—Feb. 19, 1897. No. 11,276. 30 cts.

LACHINE.

The Lachine Rapids Power Plant, Montreal, P. Q. Wm. L. Bishop. Illustrated detailed description of the plan for power development. 4,500 w. Eng News—Feb. 18, 1897. No. 11,128. 15 cts.

MALTBY.

Maltby Electric Plant. Frederic C. Whitmore. Illustrated description of a successful electric hoisting and pumping plant, showing how difficult conditions were overcome by the use of electricity as a means of transmitting power at the Lehigh Valley Coal Co.'s Maltby Mine. 2,000 w. Col Eng—Feb., 1897. No. 11,065. 30 cts.

POWER Plants.

The Power Plants of Two Large Department Stores. Illustrated detailed description of the power and electric plants of the Chicago and New York stores of Siegel, Cooper & Co. 3,500 w. Power—March, 1897. No. 11,346. 15 cts.

SWITCH-GEAR.

A Few Practical Notes on Alternate-Current Switch-Gear. L. Andrews. Read before the Northern Soc. of Elec. Engs. Part first describes a safety device and cut-out, with introductory remarks. 1,100 w. Elec Eng, Lond—Jan. 29, 1897. Serial. 1st part. No. 10,981. 30 cts.

TORQUE.

The Torque of the Triplex Pump. Cyrus T. Brown. Showing the advantage in using the triplex pump, rather than the single plunger or double-acting pump when driven by an electric motor. 1,000 w. Am Mach—March 4, 1897. No. 11,350. 15 cts.

TRANSFORMERS.

Faults and How to Find Them. Discusses faults in transformers. 1,600 w. Prac Eng—Feb. 12, 1897. No. 11,159. 30 cts.

TRANSMISSION.

The Long-Distance Transmission of Power at Hartford. Illustrated description of the engineering problems, of which the recent extensive changes made in the system are considered a satisfactory solution. 1,800 w. Elec Wld—Feb. 13, 1897. Serial. 1st part. No. 11,037. 15 cts.

A 10,000-Volt Transmission Plant. Walter King. Abstract of an article in the Elektrotechnische Zeitschrift. Illustrated description of the transmission from Eichdorf to Grünberg. 1,300 w. Elect'n—Feb. 5, 1897. No. 11,081. 30 cts.

TELEGRAPHY AND TELEPHONY.

BERLINER.

The Berliner Microphone Case. E. F. Frost. Believing that there is a misconception of the Berliner case, the writer gives a statement explanatory of the question. 1,700 w. Elec Wld—Feb. 27, 1897. No. 11,257. 15 cts.

CABLE.

The "Rapid Cable." Comments on an article in the "Pall Mall Gazette," in which the construction of the cable as recommended by Silvanus P. Thompson is discussed. 2,000 w. Elec Rev, Lond—Jan. 29, 1897. No. 10,982. 30 cts.

SUBMARINE.

Sixty Years of Submarine Telegraphy. W. E. Ayrton. Abstract of a lecture delivered at the Imperial Inst. Historical review. 5,000 w. Elect'n—Feb. 19, 1897. No. 11,274. 30 cts.

SWITCH.

Watson Telephone Switch Patent Held to Be Invalid for Want of Novelty. The text of Judge Showalter's opinion, with reproductions of drawings in the patent. 2,800 w. W Elec—Feb. 20, 1897. No. 11,146. 15 cts.

TELEGRAPHY.

Telegraphing Without Wires. H. J. W. Dam. Gives interviews with Dr. Bose and Signor Marconi and explains their investigations in this field. Ill. 7,400 w. McClure's Mag—March, 1897. No. 11,229. 15 cts.

TELEPHONY.

American Telephone Practice. Kempster B. Miller. Illustrated description of battery transmitters. 1,500 w. Am Elect'n—Feb., 1897. No. 11,222. 15 cts.

The Future Developments of Telephony. (Die Gegenwärtige Entwickelung des Fernsprechwesens.) An elaborate paper read before the Electrotechnic Society in Berlin by Jul. H. West. Proposes to cover the country with a network system of long-distance wires to be worked in connection with central stations. Two articles. 15,000 w. Elektrotechnische Zeitschrift—Feb. 4 and 11, 1897. No. 11,437, 30 cts.

TRANSMITTERS.

Telephone Transmitters. Dr. V. Weitlisbach. Illustrated description of the construction and working of transmitters based on the two fundamental types—contact, and powder or grain transmitters. 4,000 w. Elec Engng—March, 1897. Serial. 1st part. No. 11,139. 15 cts.

MISCELLANY.

ALTERNATING Current.

Mechanical Representation of Electrical Phenomena and Investigations of Resonance of Alternating Currents. (Mechanische Hülfsvorstellungen bei elektrischen Vorgängen und Untersuchungen über Wechselstromresonanz.) An elaborate mathematical treatment by Dr. Heinke, of Munich. 12,000 w. Elektrotechnische Zeitschrift—Feb. 4, 1897. No. 11,435. 15 cts.

BATTERY.

Electric Bells and Batteries. W. A. Wittbecker. From Carpentry and Building. Discusses batteries, describing their chemical action and means of detecting a weak battery, with some points on the adjustment of bells. 1,500 w. Met Work—Feb. 13, 1897. No. 11,003. 15 cts.

CARBON.

Electricity from Carbon Without Heat. Willard E. Case. A lecture delivered before the N. Y. Elec. Soc., Feb. 24. A résumé of the subject, giving the essential features of the devices thus far employed to oxydize carbon without heat, and suggesting the line along which the writer thinks success most probable. 5,000 w. Elec Eng—March 3, 1897. No. 11,320. 15 cts.

CARBON.

The Transition of Carbon from the Non-Conducting Into the Conducting Condition. George Brion. Investigations to determine at what temperature and in what manner this transition of carbon from the non-conducting to the conducting condition takes place. Abstract from Wied. Ann. 1,800 w. Elect'n—Feb. 5, 1897. No. 11,080. 30 cts.

CIRCUIT.

Calculation of Circuit. Frederic A. C. Perrine. The proper use of the different kinds of insulation under varying conditions; the selecting of a conductor for carrying a definite amount of energy; size of wire and all related topics are discussed. Illustrations and diagrams. 8,000 w. Elec Engng—March, 1897. No. 11,140. 15 cts.

DEAD Wire.

Dead Wire on Armatures. Richard Pfund. Gives the writer's reason for the wire on the inside not being as active in developing e. m. f. as that on the outside. 800 w. Elec Eng—Feb. 10, 1897. No. 10,786. 15 cts.

DIELECTRICS.

Some Dielectrics and Their Insulating Properties. George T. Hanchett. Practical consideration of exceptions to the results given of the dielectric strength of insulators as measured by formulas. 1,000 w. Elec Wld—Feb. 6, 1897. No. 10,971. 15 cts.

EARTH.

The Earth as a Conductor. Dr. Louis Bell. A study of the value of the earth as a conductor and its limitations. Only in telegraphy does it appear to serve a permanently useful purpose. 2,400 w. Am Elect'n—Feb., 1897. No. 11,218. 15 cts.

ELECTROMAGNETS.

Economy in the Design of Electromagnets. W. E. Goldsborough. The writer believes that the best results are to be obtained by working just below rather than just above the knee of the magnetism curve, although the latter is the usual practice. 700 w. Elec Wld—Feb. 6, 1897. No. 10,973. 15 cts.

ELECTROTECHNICS.

Electrotechnics, at the Hungarian Millenial Exposition (Die Elektrotechnik in der Millenniums-Landesausstellung zu Budapest.) Giving illustrated descriptions of electric tools, motors, locomotives, &c., shown at Budapest. 4,500 w. Zeitschr. d. Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,404. 30 cts.

FIRE-ALARM.

Test of Fire-Alarm Boxes. Report of the findings of the commission selected to test the fire-alarm boxes of Chicago, with brief editorial comment. 2,500 w. W Elec—Feb. 13, 1897. No. 11,006. 15 cts.

FIRE Risk.

Fire Risks at Electricity Works. G. Pearson. A discussion of the question, considering some of the suggestions made for solving the problem of municipal insurance with the difficulties. 2,800 w. Prac Eng—Feb. 5, 1897. No. 11,082. 30 cts.

Insurance as Affected by Electrical Construction. G. S. McLaren. Abstract of a paper read before the Northwestern Elec. Assn. Discusses the position taken by underwriters in regard to the use of electricity, and calls attention to dangers to be avoided. 1,500 w. Elec Eng—Feb. 10, 1897. No. 10,985. 15 cts.

FITTINGS.

A New System of Electrical Fittings (Ueber ein neues System von Installations und Sicherungsmaterialen.) A pa-

per read before the German Electrotechnical Society by Herr Hundhausen, describing the connections, conductors, fittings, &c., used by Messrs. Siemens & Halske. 9,000 w. Elektrotechnische Zeitschr—Jan. 14 and 21, 1897. No. 11,430. 30 cts.

GAS.

Gaseous Fuel as a Means of Cheapening Electricity. Nelson W. Perry. Read before the Northwestern Elec. Assn. at Milwaukee. A discussion of the subject, and suggestions of means for securing the best economical results. 4,400 w. W Elec—Feb. 13, 1897. No. 11,005. 15 cts.

HYSTERESIS.

Calculation of Loss from Hysteresis. (Zur Berechnung der Eisenverluste in Alternatoren der sogenannten Induktortyps.) A mathematical treatment of the subject by Dr. Behm-Eschenberg. 1,000 w. Elektrotechnische Zeitschrift—Jan. 14, 1897, No. 11,428. 15 cts.

Calculation of Loss from Hysteresis in Grooved Armatures. (Zur Berechnung von Eisenverlusten in Nuthenankern.) Treated analytically and graphically by Dr. Max Breslauer, of Frankfurt a. M. 1,500 w. Elektrotechnische Zeitschrift—Feb. 11, 1897. No. 11,438. 15 cts.

ISOLATED Plant.

Electricity at the Hebrew Technical Institute, New York. Illustrated detailed description. 1,500 w. Elec Eng—March 3, 1897. No. 11,319. 15 cts.

ROENTGEN Rays.

Improved Tubes for Roentgen Rays. (Ueber eine Verbessurung an den Roentgenrohren.) Discusses the various methods of diminishing the injurious effect of the bombardment upon the walls of the Crookes tube, describing the apparatus of Porter, Fomm, and the author, Dr. Arnold Berliner. 1,500 w. Elektrotechnishe Zeitschrift—Feb. 11, 1897. No. 11,439. 15 cts.

The Roentgen Ray and Its Relation to Physics. A topical discussion. Prof Henry A. Rowland makes the opening remarks and is followed by M. I. Pupin, Elihu Thomson, A. E. Kennelly and others. 19,000 w. Trans Am Iinst of Elec Engs—Dec., 1896. No. 11,232. 45 cts.

SWITCH Gear.

A Few Practical Notes on Alternate Current Switch-Gear. L. Andrews. Read before the Northern Soc. of Elec. Engs. Description and a diagram of a safety device used by the writer, with record of its action. 3,000 w. Ind and Ir—Feb. 12, 1897. Serial. 1st part. No. 11,196. 30 cts.

THREE-PHASE System.

Saving of Copper in Three-Phased Transmission Lines. Defines a three-phased system and gives method of calculating the comparative amounts of copper required for three-phase and for single alternating current systems. 1,200 w. Am Elect'n—Feb., 1897. No. 11,219. 15 cts.

X RAY.

How to Keep X-Ray Tubes in Condition While Working. Max Osterberg. Suggestions tending to prolong the life of tubes and to keep them in the best condition. 800 w. Elec Eng—Feb. 10, 1897. No. 10,984. 15 cts.

MARINE ENGINEERING.

BOILERS AND ENGINES.

BEARINGS.

See "Bearings," under Mechanical Engineering, Miscellany.

DRAUGHT.

Suction Draught for Marine Boilers. Matthew Paul. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. The results of tests and experience are given. It was claimed that in safety of boilers under high rates of steaming, economy of coal, ease and simplicity of working and structural arrangements, suction draught had distinct advantage over forced draught. 2,800 w. Eng, Lond.—Feb. 5, 1897. No. 11,030. 30 cts.

DUTY Test.

A Method of Determining a Continuous Record of the Performance of a Marine Engine. W. F. Durand. Discusses the desirability of continuous records and considers the elements involved in them and the ways and means of obtaining them. 500 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,154. $1.25.

NAVAL AFFAIRS.

BATTLESHIP.

The Japanese Battleship "Yoshima." Brief illustrated description. 2,000 w. Engng—Feb. 5, 1897. No. 11,023. 30 cts.

COMPRESSED Air.

Proposed Extension of the Use of Compressed Air on Men-of-War. See title, Naval Use, under Mechanical Engineering—Compressed Air.

The U. S. S. Terror and the Pneumatic System as Applied to the Guns, Turrets and Rudder. T. W. Kinkaid. General data of the ship and machinery, with illustrated description of the pneumatic system. 3,000 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,155. $1.25.

DRY Docks.

The Timber Dry Docks at the Brooklyn Navy Yard. Illustrated detailed description of new dock No. 3, construction, cost, &c. 1,800 w. Sci Am—Feb. 20, 1897. No. 11,103. 15 cts.

SEARCH Light.

See same title under Electrical Engineering—Lighting.

SPEED.

The Speed Problem. J. A. Normand.

Read before the Assn. Technique Maritime, Paris. A study of the speed of torpedo boats, the causes of recent progress and the possible causes for future progress. 3,200 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,156. $1.25.

WARSHIPS.

Modern Warships. (Die heutige Kriegsmarinen.) Von Neudeck. Illustrated and tabulated descriptions of the most recent Italian and Russian warships. 5,000 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,406. 30 cts.

MISCELLANY.

DIVING.

Some Facts About Diving Apparatus, &c. Discusses the business of Messrs. Barnett and Foster, specialists in the matter of diving apparatus. 2,300 w. Trans—Feb. 12, 1897. No. 11,183. 30 cts.

FREIGHT Steamer.

The Pennsylvania, the Largest Freight Steamer in the World. Illustrated description. 900 w. Sci Am—Feb. 27, 1897. No. 11,210. 15 cts.

FUEL.

Liquid Fuel. R. R. Wallis. Read before the Northeast Coast Inst. Applies to the use of petroleum residues on board of steamships. 2,500 w. Prac Eng—Feb. 19, 1897. No. 11,277. 30 cts.

MERCANTILE Marine.

New Laws in Japan for the Development of the Mercantile Marine. Gives the text of two laws for the development of the Japanese Mercantile Marine and the encouragement of shipbuilding in that country. 1,800 w. Bd of Trd Jour—Feb., 1897. No. 11,295. 30 cts.

The American Mercantile Marine. Comment on the report of the Commissioner of Navigation, dealing with the laws of the United States relative to navigation. 2,400 w. Bd of Trd Jour—Feb., 1897. No. 11,294. 30 cts.

ROLLER Ship.

Bazin Roller Ship. (Der Rollendampfer "Ernest Bazin.") Line drawing, with dimensions and other data, of the Bazin vessel about completed for use on the Channel. 1,000 w. Zeitschr d Oesterr Ing u Arch Vereines—Jan. 22, 1897. No. 11,423. 15 cts.

NAPHTHA Launch.

The Naptha Launch of the Gas-Engine and Power Company of New York City. Illustrated description. 900 w. Sci Am Sup—Feb. 27, 1897. No. 11,213. 15 cts.

PROJECTORS.

See same title under Electrical Engineering—Lighting.

SHIPBUILDING.

German Shipbuilding. (Deutsche Werften.) A review of shipbuilding going on at present in the leading German yards, with illustrations of the new North German Lloyd Steamer "Kaiser Friedrich." 3,000 w. Zeitsch d Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,405. 30 cts.

SHIPPING.

Projected Steamship Enterprises. Some account of the interest the Japanese are giving to shipping interests, and the effect upon trade that could be expected if the shipping facilities were improved. 2,000 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,174. 45 cts.

STEERING Gear.

Electric Steering Gear. (Elektrische Steuerruder Maschine.) Illustrated description of Essberger's electric steering engine, now being applied in the German Navy. Two motors running in opposite directions are geared to an epicyclic train, and one or the other overruns according to the motion of the controlling lever. 2,000 w. Elektrotechnische Zeitschrift—Feb. 4, 1897. No. 11,436. 15 cts.

VIBRATION.

The Prevention of Vibrations of Steamships. John H. Macalpine. The object of the paper is to show how, by mechanical means, the vertical transverse vibrations of the periods higher than the first may be almost entirely prevented. 5,800 w. Engng—Feb. 19, 1897. No. 11,304. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER Defects.

Defects in Steam Boilers. Abstract from the second report of the committee of the Austrian Soc. of Engs. and Archts., relating to stationary boilers. Ill. 3,300 w. Eng News—Feb. 11, 1897. No. 11,019. 15 cts.

BOILER Scale.

Incrustations in Boilers. (Incrustants et Désincrustants.) M. Dibos. An investigation into the causes and character of boiler incrustations, with analyses and suggestions for remedies. Especially referring to marine boilers. 6,000 w. La Revue Technique—Jan. 25, 1897. No. 11,408. 30 cts.

EXPLOSIONS.

Heat and Boiler Explosions. James Wright. Paper read before Montreal C. A. S. E. Briefly outlines the views held as to what heat is, considers the mechanical equivalent and the behavior of water when subjected to heat. 4,500 w. Can Elec News—Feb., 1897. No. 10,970. 15 cts.

Boiler Explosions and Failures from Hidden Defects. From "The Locomotive." Illustrated description of causes of failures. Fractured plates, hidden cracks, possible in all types of boilers that have riveted shells and lap joints. 2,000 w. Age of St—Feb. 27, 1897. No. 11,272. 15 cts.

FEED-WATERS.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. Describing the phenomena of pitting, grooving

and general corrosion, the theories offered in explanation of them, and the means of their prevention. Ill. 6,800 w. Eng Mag—March, 1897. No. 11,341. 30 cts.

FURNACE Gases.

The Presence of Hydrogen, Hydrocarbons and Nitrogen Peroxide in Boiler Furnace Gases. R. S. Hale. Collection of data showing that, though the presence of the nitrogen peroxide accounts for the missing oxygen, yet the amounts of carbon dioxide, oxygen and carbonic oxide in the gas can in no case prove the absence of hydrogen or hydrocarbons. 1,200 w. Eng News—Feb. 18, 1897. No. 11,130. 15 cts.

FUSIBLE Plug.

Fusible Plugs in Boilers. W. A. Carlile. Describes the principal types of fusible plugs and states their advantages and disadvantages. 2,300 w. Safety V—Feb., 1897. No. 11,042. 15 cts.

GAGES.

Water-Gages for High-Pressure Steam Boilers. T. C. Billetop. Read before the Northeast Coast Inst. of Engs. and Shipbuilders. Presents the advantages of the talc gage, with diagram. 1,500 w. Col Guard—Feb. 12, 1897. No. 11,169. 30 cts.

INJECTOR.

The Injector. J. Warren. Describes briefly the theory and construction, with the methods of working. 1,600 w. Elec, Lond—Jan. 22, 1897. No. 11,024. 30 cts.

SAFETY Valve.

Safety-Valves on Low-Pressure Boilers. Criticises the practice of placing of safety-valves of insufficient area of opening. 1,300 w. Bos Jour of Com—Feb. 27, 1897. No. 11,261. 15 cts.

STOKING.

Machine Firing. Edward Bennis. Review of attempts in the direction of machine firing, with description of the construction and work of a machine. Discussion follows. 3,800 w. Col Guard—Feb. 5, 1897. No. 11,078. 30 cts.

COMPRESSED AIR.

AIR Lift Pumps.

See same title under Municipal Engineering—Water Supply.

COMPRESSED Air.

Advantages of Compressed Air. Jas. F. Lewis. A very complete history of the progress of this power from the earliest recorded experiments to the present day, giving its numerous uses. Ill. 7,000 w. Can Min Rev—Feb., 1897. No. 11,330. 30 cts.

Compressed Air. Some of the uses to which it is being put in different ways. 1,300 w. Bos Jour of Com—Feb. 20, 1897. No. 11,161. 15 cts.

ELECTRIC Power.

Compressed Air vs. Electricity. Fredk. S. Watkins. Briefly compares the first cost, efficiency, cost of operation, reliability and difficulties. 1,000 w. Compressed Air—Feb., 1897. No. 11,111. 15 cts.

Fairness in Comparing Air and Electric Power. Editorial advising the partisans of each power to devote their energies to the selection of the legitimate field and the development of the power in which they are interested. 1,000 w. Ry Rev—Feb. 27, 1897. No. 11,308. 15 cts.

Is Compressed Air Destined to Become the Rival of Electricity? Joseph W. Buell, in Inventive Age. Discusses the changes brought about by electricity, gives history of the early attempts to use compressed air, and a brief account of the power yielded and applications. 2,400 w. Compressed Air—Feb., 1897. No. 11,110. 15 cts.

MARINE Uses.

See title Compressed Air under Marine Engineering, Naval Affairs.

NAVAL Use.

Proposed Extension of the Use of Compressed Air on Men-of-War. F. W. Bartlett. Suggests ways of using air and states why it is better for many purposes than either steam or electricity. 1,700 w. Am Mach—Feb. 18, 1897. No. 11,123. 15 cts.

PNEUMATIC Tubes.

Locating Obstructions in Underground Pneumatic Tubes in Philadelphia. B. C. Batcheller. An interesting account of efforts made based on the velocity of sound waves, and the degree of success attained. 1,700 w. Eng News—March 4, 1897. No. 11,353. 15 cts.

SHOP Use.

Pneumatic Power Applied to Workshops. John Davis Barnett. From the Trans. of the Can. Soc. of Civ. Engs. The present position of air power, as part of a craft, illustrated more especially by railway shop work. 4,800 w. Prac Eng—Feb. 5, 1897. No. 11,083. 30 cts.

RAILROAD Use.

See title Snow-Flanger under R. R. Affairs—Equipment.

ENGINES AND MOTORS.

CONDENSERS.

Central Condensers. (Ueber Central-Condensation.) A description of condensing plant in which a number of engines exhaust into one large condenser; with illustrations of the apparatus at the "Ewald" mine in Westphalia. 4,000 w. 1 plate. Zeitschr. d. Oesterr. Ing. u. Arch Vereines—Jan. 22, 1897. No. 11,421. 15 cts.

DUTY Tests.

Efficiency of Different Types of the Steam Engine. Comparisons made on the basis of engines working in a Carnot cycle are given in part first. 1,200 w. Am Elect'n—Feb., 1897. Serial, 1st part. No. 11,217. 15 cts.

See same title under Marine Engineering, Engines and Boilers, and Mechanical Engineering Miscellany.

DYNAMO.

See Electrical Engineering—Power.

GAS-ENGINE.

Discussion: "The Large Gas Engine; Its Present Development and Forecast of Its Future." Discussion of Mr. Lloyd's paper at the annual meeting of the Ohio Gas Lgt. Assn. 3,000 w. Am Gas Lgt Jour—Feb. 22, 1897. No. 11,194. 15 cts.

Gas and Gasoline Engines. M. T. Monogue. Endeavors to explain the care needed, the troubles arising and remedies, in this class of machinery. 1,100 w. Sci Mach—March 1, 1897. No. 11,321. 15 cts.

The "Cosmos" Gas Engine. Moteur à Gaz, "Cosmos." Illustrated description of a very neat and simple vertical gas engine recently brought out in Paris. 1,000 w. La Révue Technique—Feb. 10, 1897. No. 11,415. 30 cts.

The Large Gas-Engine. Its Present Development and Forecast of Its Future for Electrical Purposes. E. F. Lloyd. Brief review of the single-acting and double-acting engines and the advantages and improvements in detail and construction. 4,000 w. Am Gas Lgt Jour—Feb. 15, 1897. No. 11,033. 15 cts.

INDICATOR.

The Steam-Engine Indicator. Discusses the faulty points and lines, giving a series of cards showing some of the incorrect positions and illustrating remedies. 1,400 w. Prac Eng—Feb. 12, 1897. No. 11,160. 30 cts.

MOTOR.

Designs for Small Motors. Cecil P. Poole. Part first gives working drawings for the construction of a 1-6 h.-p. motor with drum armature, for operation upon a 110-volt continuous-current circuit, with descriptions. 1,800 w. Am Elect'n—Feb., 1897. Serial. 1st part. No. 11,221. 15 cts.

SLIDE-VALVE.

The Slide Valve Diagram. Treats merely of the practical construction. 1,400 w. Am Elect'n—Feb., 1897. No. 11,226. 15 cts.

TURBINE.

High-Pressure Turbine Wheel, with Hydraulic Regulator. (Hochdruk-Turbine mit hydraulischer Patent-Regulierung). A turbine of the Pelton type, controlled by a centrifugal governor and differential hydraulic gear, constructed by Theo. Bell & Cie, of Kriens, Switzerland. 1,000 w. Schweizerische Bauzeitung—Feb. 6, 1897. No. 11,448. 15 cts.

POWER AND TRANSMISSION.

BEARINGS.

Machinery Bearings. John Dewrance. The results of a series of experiments undertaken to determine the frictional resistance to shafts revolving in bearings under varying loads, when subjected to different conditions. Also "The Bearings of the Marine Engine." Ill. 6,500. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,157. $1.25.

BELTING.

Notes on Belting. Fred W. Taylor. A paper presented to the A. S. M. E. three years ago, but reprinted because of its value as a complete treatise on the subject. 4,500 w. Eng, Lond—Feb. 5, 1897. Serial. 1st part. No. 11,028. 30 cts.

MINING.

Power Transmission for Mining Work. See Power Transmission under Mining and Metallurgy, Mining.

PAPER WHEELS.

Paper Wheels for Transmission of Power. George D. Rice. Report on a series of experiments which were undertaken with the view of determining the practicability and efficiency of paper wheels for the transmission of power. 1,000 w. Ir Age—Feb. 11, 1897. No. 10,993. 15 cts.

SHOP AND FOUNDRY.

BRASS MOLDING.

A Pattern for a Difficult Brass Casting. Charles H. Allmond. Describes the casting of a very thin receiver pipe for a triple-expansion engine. 800 w. Am Mach—Feb. 18, 1897. No. 11,119. 15 cts.

CHILLED ROLLS.

A Method of Casting Chilled Rolls. Cuts and description taken from a pamphlet issued by the Lewis Foundry and Machine Co., of Pittsburg. 2,000 w. Ir Trd Rev—Feb. 25, 1897. No. 11,255. 15 cts.

CHIPS.

Helical and Spiral Chips—Easy Rolling Chips. Tecumseh Swift. Calling attention to the fact that the chip made on the lathe is helical, while the chip made on the planer is spiral. 1,500 w. Am Mach—Feb. 11, 1897. No. 10,998. 15 cts.

DRESSING.

A New Method of Dressing Car Wheels, Axles, etc. See Car Wheels, Axles, etc., under Railway Affairs—Equipment.

DRUMS.

Strength of Hoisting Drums. Charles Lewis. Analysis of the strains. 800 w. Am Mach—Feb. 11, 1897. No. 10,997. 15 cts.

EMBOSSING.

Embossing Presses. (Nouvelles Presses à Emboutir.) Illustrated description of the American presses of the E. W. Bliss Co. 2,000 w. La Revue Technique—Jan. 25, 1897. No. 11,411. 30 cts.

FLY-WHEELS.

De La Vergne Fly-Wheels. An illustrated detailed description of the construction of these wheels. 1,600 w. Am Mach—Feb. 11, 1897. No. 10,995. 15 cts.

GAGING.

Correct Gaging in Mounting Car Wheels. See title Car Wheels under Railroad Affairs—Equipment.

GEARS.

Gear Molding and Gear Molding Machines. S. Groves. Read before the Nat. Foundrymen's Convention. Some particulars and practical details noted in the process of actual manufacture. Ill. 2,400 w. Foundry—Feb., 1897. No. 11,127. 15 cts.

The Strength of Gear Teeth. Henry Hess. Diagrammatic solution of the load that may be imposed on a gear tooth, with discussion of formulae. 1,500 w. Am Mach—Feb. 18, 1897. No. 11,121. 15 cts.

GRINDING MACHINE.

The Use of the Grinding Machine. John Randol. Some ideas and occurrences from the writer's observation and experience, and also information from the

Brown & Sharp Mfg. Co. Ill. 4,000 w. Am Mach—Feb. 25, 1897. No. 11,204. 15 cts.

HEAD STAMPING.

Lock Joint Head Stamping. How to Make It and the Tools for It. W. A. Warman and Thomas A. Dicks. Describes a process which gives a stamping in which the metal is thicker by 10 to 20 per cent. at the points of greatest strain. Ill. 1,200 w. Am Mach—Feb. 25, 1897. Serial. 1st part. No. 11,203. 15 cts.

LAP-WELDING.

Making Lap-Welded Pipe. Describes the process of manufacture as carried out at the plant of the National Tube Works Company, at McKeesport, Pa. 1,200 w. Am Mfr & Ir Wld—Feb. 19, 1897. No. 11,184. 15 cts.

LATHE.

One Million Shapes for a Diamond-Point Lathe Tool. How to Designate Them. Tecumseh Swift suggests a scheme for accurately describing and recording the shape of the cutting point of the tool. 1,500 w. Am Mach—Feb. 18, 1897. No. 11,122. 15 cts.

MOLDING.

Molding Hawse Pipes at the Bath Iron Works Foundry. George W. Dean. Illustrated, description. 900 w. Am Mach—Feb. 11, 1897. No. 10,996. 15 cts.

The Bryant Revolving Molding Machine. Illustrated description of the invention of Orrin Bryant. 800 w. Eng News—Feb. 18, 1897. No. 11,132. 15 cts.

SHOP Management.

Six Examples of Successful Shop Management. Henry Roland. Showing the decline of the contract system in machine shops. 3,200 w. Fifth paper. Eng Mag—March, 1897. No. 11,344. 30 cts.

MISCELLANY.

AMERICAN Machinists and Tools.

American Machine Tools and Other Products as Seen Through Foreign Eyes. Substance of an interview with Herr Von Meyenburg, a Swiss engineer, with editorial. Claims that American tools are better, but machines inferior. 2,800 w. Am Mach—March 4, 1897. No. 11,351. 15 cts.

APPRENTICESHIP System.

The Improvement of the Apprenticeship System as a School for Mechanics. Discussion of the relation of employer and apprentice and the means of making this system of value, with reasons. 2,800 w. Eng News—March 4, 1897. No. 11,355. 15 cts.

CONVEYORS.

Coal Handling Plant of Coxe Bros. & Co., Clybourne Ave. Docks, Chicago, Ill. Illustrated deta[illegible] description. 2,300 w. Eng News—F[illegible] 1897. No. 11,016. 15 cts.

[illegible]TY T[illegible]

Watt [illegible]ment of Power. [illegible] [illegible]att Anniversary [illegible] [illegible]reenock, Feb. 5. [illegible], dealing largely with Watt's measurement of power and its present use, with editorial comment. 4,500 w. Elect'n—Feb. 12, 1897. No. 11,189. 30 cts.

HEAT Transmission.

Transmission of Heat Through Metal Plates. (Ueber den Wörmedurchgang durch Metallplatten.) Report upon experimental determination of transmission of heat through plates of steel of various thickness for various differences of temperature. 1,500 w. Zeitschr. d. Oesterr. Ing u Arch Vereines—Jan. 29, 1897. No. 11,425. 15 cts.

INVENTION.

Cultivation of the Inventive Capacity by the Solution of Constructive Problems. Leicester Allen. Presents problems and gives solutions. Ill 2,200 w. Am Mach—March 18, 1897. No. 11,120. 15 cts.

LUBRICATION.

Superficial Tension and Lubrication. R. M. Deeley. The phenomena arising from superficial tension are studied in so far as they concern lubricating problems. 6,300 w. Eng, Lond—Feb. 12, 1897. No. 11,166. 30 cts.

MACHINES.

Dissimilar Action of Similar Machines. William Baxter, Jr. Considers the causes that tend to vary the action of machines. 2,800 w. Elec World—Feb. 20, 1897. No. 11,188. 15 cts.

METRIC System.

The Metric System Lunacy. Part first criticises statements made by Frederick A. P. Barnard, and arguments tending to show that the measurements now used are better. 2,800 w. Engng Mech—Feb., 1897. Serial. 1st part. No. 11,271. 30 cts.

MILL.

Roller Mill. (Moulin à Blé à Cylindres.) Detailed description, with illustrations and plate showing plans of building, of a roller mill of 6,000 lbs. capacity in 24 hours, erected at Soulièvre. 4,000 w. La Revue Technique—Jan. 25, 1897. No. 11,409. 30 cts.

SMOKE Prevention.

The Suppression of Smoke by the Use of Coke. O. Simmersbach, in Zeitschrift der Dampfkessel-Ueberwachungs-Vereine. Treats of the substitution of coke for coal and arrives at the conclusion that general heating by coke is practicable, and presents important technical and economical advantages. 5,500 w. Pro Age—Feb. 15, 1897. No. 11,117. 15 cts.

TESTING.

Mechanical and Physical Tests Compared. S. S. Knight. The writer believes the best results will be attained by the use of both chemical and mechanical tests. 3,000 w. Foundry—Feb., 1897. No. 11,126. 15 cts.

Mirror Apparatus for Testing. Gus C. Henning. Explains what a mirror apparatus really is, and gives illustrated description of design by the writer. 1,500 w. Am Mach—Feb. 11, 1897. No. 10,994. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

AUSTRALIA.

Coal in Western Australia. Report of H. P. Woodward, government geologist, on the carboniferous areas of the Irwin River basin. 1,600 w. Col Guard—Feb. 5, 1897. No. 11,075. 30 cts.

BLOCK Coal.

The Block Coal Region of Indiana. Brief description of location, appearance, manner of working, &c. 800 w. Eng & Min Jour—Feb. 13, 1897. No. 11,011. 15 cts.

FRANCE.

Colliery Working in the Loire, France. M. Tauzin. From an official report by the government inspector. Deals with production, methods of working, wages, ventilation, explosives, pumping, &c. 1,500 w. Col Guard—Feb. 19, 1897. No. 11,300. 30 cts.

MACHINE Mining.

Coal Cutting Machines. Cyrus Robinson. The comparative advantages and disadvantages of compressed air and electrically driven machines over pick mining. 1,200 w. Col Eng—Feb., 1897. No. 11,069 30 cts.

NEVADA.

The Coal Fields of Esmeralda County, Nev. M. A. Knapp. A description of this coal field and its interesting stratigraphical relations. 1,400 w. Min & Sci Pr—Feb. 13, 1897. No. 11,102. 15 cts.

HOCKING Valley.

The Hocking Valley Coal Region in Ohio. (Describes the character of the coal, methods of mining, ventilation, &c. 800 w. Eng & Min Jour—Feb. 27, 1897. No. 11,250. 15 cts.

COPPER.

ARIZONA.

Arizona's Copper Mines. Arthur Lakes. The Governor's report on the mineral resources of the territory and some observations by a prospector. 1,500 w. Col Eng—Feb., 1897. No. 11,068. 30 cts.

CALIFORNIA.

The Randsburg Mining District, California. F. M. Endlich. Gives a brief synopsis of the leading properties now in operation, with favorable report of the district. 1,900 w.) Eng & Min Jour—Feb. 27, 1897. No. 11,247. 15 cts.

REFINING.

Some Recent Developments in Copper Manufacture. Harold P. Brown. Analysis, tests and experiments with what is known as M. B. copper, proving its value to electrical engineers on account of high conductivity. 2,000 w. Elec Rev—March 3, 1897. No. 11,313. 15 cts.

GOLD AND SILVER.

ARIZONA.

Mining in Gavapai County, Arizona. John F. Blandy. Favorable account of the mining progress of this region, which has five leading gold mines. 800 w. Eng and Min Jour—Feb. 27, 1897. No. 11,249. 15 cts.

AUSTRALIA.

A Neglected Goldfield. An account of the Hodgkinson goldfield by the government geologist. 4,000 w. Aust Min Stand—Dec. 31, 1896. No. 11,000. 30 cts.

The Goldfields of Western Australia. Harry C. Rhys Jones. Considers the future of this region one of golden promise. 2,200 w. Aust Min Stand—Jan. 14, 1897. No. 11,093. 30 cts.

BRITISH COLUMBIA.

Notes on the Gold-Bearing Lodes of Cayoosh Creek, B. C. G. F. Moncton. The writer thinks there is good cause to believe this will become a famous mining camp, and gives reasons for his opinions. 1,600 w. Can Min Rev.—Feb., 1897. No. 11,331. 30 cts.

The Revival of Mining in Cariboo, B. C. Gives past history of this gold region and the arrangements recently made to develop the wealth of this district. 4,000 w. Can Min Rev.—Feb., 1897. No. 11,325. 30 cts.

COLOMBIA.

The Gold Fields of the Porce River, Colombia. J. D. Garrison. Reporting the results of the writer's examination of Colombian mines. Ill. 3,100 w. Eng Mag—March, 1897. No. 11,343. 30 cts.

FOLEY Mine, Ont.

The Foley Mine, Shoal Lake, Ont. Description, with illustrations, of this celebrated gold mine, giving character of ore deposits, development and expenditures. 500 w. Can Min Rev—Feb., 1897. No. 11,326. 30 cts.

GOLD Mining.

Future of Gold Mining. Editorial review of present conditions and causes which have affected gold mining, calling attention to considerations that demand adjustment. 1,000 w. Min Ind and Rev—Feb. 18, 1897. No. 11,180. 15 cas.

Gold and Silver Mining. C. C. Goodwin. Describes the finding of some successful mines and their output. 2,800 w. Chau—March, 1897. No. 11,228. 30 cts.

GOLD Quartz Mining.

Gold Quartz Mining in Canada and Victoria, Australia. Dr. A. R. Selwyn. Facts and comparisons relating to these fields, with discussion. 5,500 w. Can Min Rev—Feb., 1897. No. 11,334. 30 cts.

HUNGARY.

Visit of the Mining Congress of Budapest to the Boicza-Bräder Gold Fields. (Der Ausflug der Theilnehmer am montanistischen Congresse zu Budapest nach den Boicza-Bräder Goldbergbauen.) An interesting account of a trip of a body of specialists to the famous Hungarian gold mines. 8,000 w. Zeitsch d Oestrr Ing u Arch Vereines—Jan. 15 and 22, 1897. No. 11,407. 45 cts.

LOW GRADE Gold Ore.
Notes of the Mining of Low Grade Gold Ore in Nova Scotia. G. F. Andrews. An outline of the writer's personal experience while manager of the Richardson mine at Isaac's Harbor, Nova Scotia. 3,000 w. Can Min Rev—Feb., 1897. No. 11,332. 30 cts.

MADAGASCAR.
Gold Traffic and Gold Mining in Madagascar. A translation of the law concerning gold export and buying which seems to threaten trouble between local authorities and foreign merchants. 3,500 w. Cons Repts—Feb., 1897. No. 11,153. 45 cts.

MOUNT Morgan.
The Mount Morgan Gold Mine. Periodical report giving the fullest information as to the work done and the result. Ill. 2,500 w. Aust Min Stand—Dec. 24, 1896. No. 10,999. 30 cts.

NEW ZEALAND.
A New Zealand Gold Mine. Facts concerning the Houraki District, with illustrations of the Crown Mine. 500 w. Eng and Min Jour—Feb. 20, 1897. No. 11,147. 15 cts.

Gold Mining in New Zealand. C. C. Longridge. Warnings and suggestions, quoting opinions of the Government Inspecting Engineer. Also Editorial. 2,500 w. Min Jour—Feb. 6, 1897. No. 11,031. 30 cts.

Mining in New Zealand. C. C. Longridge. Nature of the gold, power, blasting, crushing and stamping, cyaniding, sluices, labor and cost are briefly noticed. 800 w. Min Jour. Feb. 13, 1897. No. 11,202. 30 cts.

OREGON.
The Claims of Oregon to Prominence as a Mining Region. Describes the chief mining region of the State, showing a profitable yield of gold and valuable copper deposits. 1,600 w. Min Jour—Feb. 20, 1897. No. 11,315. 30 cts.

PLACER.
The Gravel Fields of Northern California. C. L. Hall. Information of the placer mining in Trinity and Siskiyou counties. 2,000 w. Min and Sci Pr—Feb. 6, 1897. No. 11,007. 15 cts.

QUEBEC.
The Gold-Bearing Deposits of the Eastern Township of Quebec. Robert Chalmers. The area of this gold-bearing region is estimated at from 3,000 to 4,000 sq. miles. The writer gives facts and inferences showing the prospects to be rather encouraging, but considers knowledge and skill essential to success. 4,200 w. Can Min Rev—Feb., 1897. No. 11,333. 30 cts.

RANDSBERG.
Randsberg, a Desert Mining Town. Henry G. Tinsley. An account of the wonderful growth of this mining town, its location, prospects, discovery and value. Ill. 2,400 w. Harper's Wk—March 6, 1897. No. 11,312. 15 cts.

SMELTING.
Argentiferous Lead Smelting at Leadville. Franklin Ballou, Jr. Discusses the daily operations in a smelter. 3,000 w. Yale Sci M—Feb., 1897. No. 11,125. 30 cts.

TELLURIDES.
Concerning Tellurides. What tellurides are, how they are worked and where they occur. 2,000 w. Min Jour—Feb. 20, 1897. No. 11,316. 30 cts.

WITWATERSRAND.
Economic Features of Mining on the Witwatersrand Gold Fields. Edgar P. Rathbone. Deals with the mining of gold-bearing conglomerates on the Witwatersrand, Klerksdorp and Heidelberg goldfields collectively, as the geological deposits and conditions are the same. 3,800 w. Eng & Min Jour—Feb. 13, 1897. No. 11,-010. 15 cts.

IRON AND STEEL.

ANALYSIS.
Some Present Possibilities in the Analysis of Iron and Steel. C. B. Dudley. Presidential address at meeting of Am. Chem. Soc. Survey of some of the analytical methods in use in the iron and steel industry. Only five of the constituents affecting the quality are here considered, viz.: Carbon, phosphorus, silicon, sulphur and manganese. 6,500 w. Science—Feb. 12, 1897. No. 11,049. 15 cts.

ARMOR Plate.
The Carnegie Company on Armor-Plate Costs. Extract from written statement submitted to the Senate Committee on Naval Affairs by H. C. Frick, upon the question as to what should be the price of armor-plate. 600 w. Am Mfr & Ir Wld—Feb. 12, 1897. No. 11,051. 15 cts.

BASIC Slag.
Basic Slag as a Fertilizer. F. E. Thompson. Gives experiments and results from its use in Europe, as condensed in a paper by Dr. William Frear, in the Agricultural Report of Pennsylvania for 1890. 2,400 w. Sci Am Sup—March 6, 1897. No. 11,345. 15 cts.

High Carbon Steels for Forgings. A. L. Colby. Read before the Engs.' Club of Philadelphia. The steel used in shafting, crank-pins, hammer-rods, with directions for selection of steel. 1,100 w. Ir Age—Feb. 18, 1897. No. 11,100. 15 cts.

OPEN Hearth.
The Bertrand-Thiel Open-Hearth Process. Comments on the investigations of this process made by P. C. Gilchrist, which were presented to the Cleveland Inst. of Engs. 1,500 w. Eng, Lond—Feb. 5, 1897. No. 11,026. 30 cts.

PHOSPHORUS.
Estimation of Phosphorus in the Ash of Coal and Coke. L. Campredon, in Moniteur Industriel. Gives the results of comparative tests made by the author on the ash of English coals. 700 w. Col Guard—Feb. 5, 1897. No. 11,076. 30 cts.

PIG-IRON Trade.
Review of the Pig-Iron Trade of 1896. George E. Drummond. Reviews the mar-

kets with which the Canadian iron producers have to compete and deals with the Canadian pig-iron industry in some of its bearings. Also discussion. 12,500 w. Can Min Rev—Feb., 1897. No. 11,327. 30 cts.

PIPE.

See title Cast-Iron Pipe under Municipal Engineering—Water Supply.

REVERBERATORY Furnace.

The Thwaite Steel Furnace. Illustrated description. 700 w. Eng, Lond—Feb. 12, 1897. No. 11,167. 30 cts.

TESTING of Iron and Steel.

Standardizing the Testing of Iron and Steel. P. Kreuzpointner. Showing graphically the effects of tension upon steel. Ill. 1,800 w. Second paper. Eng Mag—March, 1897. No. 11,342. 30 cts.

MINING.

DITCH Construction.

Ditch Construction in Idaho. Augustus J. Bowie. Gives details and cost of construction of Rapp's Creek ditch and flume. 2,700 w. Min & Sci Pr—Feb. 27, 1897. No. 11,347. 15 cts.

DRILL.

New Rotary Hand-Worked Rock-Drill (Liesens system). Os Derclave. Translated from Revue Universelle des Mines. Communication made to the Assn. des Ingénieurs sortis de l'Ecole de Liége (Section de Charleroi). Briefly notices the hand-drilling machines in present use, with a description of the Liesens system. Ill. 1,600 w. Col Guard—Feb. 5, 1897. No. 11,077. 30 cts.

EXPLOSIVES.

The Cost and Efficiency of Safety Explosives as compared with Gunpowder. H. Hall. A comparison between the last year gunpowder was used and the last year during which explosives have been used. 900 w. Ir & Coal Trds Rev—Feb. 19, 1897. No. 11,280. 30 cts.

MINING Engineer.

The Responsibilities of the Mining Engineer. Dr. J. B. Porter. Presents the value of the engineer from a commercial standpoint, and warns against the kinds of dishonesty especially tempting in this line of work. 2,400 w. Can Min Rev—Feb., 1897. No. 11,329. 30 cts.

MINING Law.

Remedies for Mining Damages. Laws of England as governing property acquired in mines are discussed, especially in cases requiring modification of the usual remedies. 1,800 w. Col Guard—Feb. 19, 1897. No. 11,299. 30 cts.

The Right to Vertical Support. Discusses the right of owners of the surface to absolute support of property in mining regions. 2,000 w. Col Guard—Feb. 5, 1897. No. 11,073. 30 cts.

POWER Transmission.

The Comparative Advantages and Disadvantages of Steam, Compressed Air and Electricity for Power Purposes in Coal Mining, with Special Reference to Coal-Cutting and Haulage. Charles Chetwynd Ellison. Special prize essay. Part first considers steam and compressed air, with reference to conveniences, efficiency, economy and safety. 3,700 w. Ir & Coal Trds Rev—Feb. 12, 1897. Serial. 1st part. No. 11,200. 30 cts.

PUMPING.

See "Maltby," under Electrical Engineering, Power.

TIMBERING.

Timber and Timbering. H. W. Halbaum. A lecture delivered before the Midland Counties Branch of the National Ass'n of Colliery Managers, England. The principles governing the choice of timber and the setting of props in mines; the use of iron and steel props in place of wood; the relation of the height of seam and nature of roof to strength of props; how to place props to secure the best results. 5,800 w. Col Eng—Feb., 1897. No. 11,066. 30 cts.

VENTILATION.

Furnace versus Fan Ventilation. William Clifford. Read before the Ohio Inst of Min Engs. A review of the progress made in mechanical ventilation in the past 40 years. Part first deals with the arrangements in use in early times. 1,400 w. Am Mfr & Ir Wld—Feb. 12, 1897. Serial. 1st part. No. 11,058. 15 cts.

WINDING Engines.

A Spring Coupling for Winding or Hauling Engines. Description with drawing of the invention of H. W. Hollis. 500 w. Col Guard—Feb. 12, 1897. No. 11,168. 30 cts.

MISCELLANY.

ACIDS.

Concentration of Mineral Acids. (Acides Mineraux de Haute Concentration.) Description of improved methods of concentrating sulphuric and nitric acids, with a view of reducing the loss of platinum and obtaining high concentration with greater economy. 2,500 w. La Revue Technique—Jan. 25, 1897. No. 11,410. 30 cts.

ALLOYS.

Alloys. W. C. Roberts-Austen. Fourth report of the Alloys Research Committee. Read before the Inst of Mech Engs. Deals with the present position of the research, with the copper-zinc series of alloys, with certain relations between the fusibility and strength of alloys; also gives descriptions of experiments. 5,700 w. Engng —Feb. 12, 1897. Serial. 1st part. No. 11,165. 30 cts.

ALUMINUM.

See same title under Electrical Engineering, Electro-Chemistry and Metallurgy.

BRITISH Columbia.

The West Kootenay Mines. Extracts from the report published by the Bureau of Mines of British Columbia on the Slocan, Nelson and Ainsworth mining districts in West Kootenay, written by William A. Carlyle. 1,500 w. Min & Sci Pr—Feb. 20, 1897. No. 11,236. 15 cts.

CALIFORNIA.

Outline of the Geology of California, with References to Its Mineral Deposits. Harold W. Fairbanks. This series of articles aims to awaken an interest in the study of geology as well as impart some information which shall be of value to miners. 1,400 w. Min & Sci Pr—Feb. 13, 1897. Serial. 1st part. No. 11,101. 15 cts.

DIAMONDS.

Diamonds in the Gwydir Valley (N. S. W.) L. O. B. Describes facts concerning them. 1,500 w. Aust Min Stand—Jan. 7, 1897. No. 11,001. 30 cts.

GEMS.

Precious Stones of New South Wales. J. Milne Curran. Information based on the writer's personal observations, illustrated by original photographs. 5,000 w. Aust Min Stand—Jan. 14, 1897. Serial. 1st part. No. 11,094. 30 cts.

IDAHO.

The Seven Devils' Mountains. A. F. Wuensch. Information of this district in Idaho, which promises soon to be opened by a railway. Description of mines. 2,300 w. Min Ind & Rev—Feb. 18, 1897. No. 11,181. 15 cts.

IODINE.

New Method of Extracting Iodine. (Nouvelle Methode d'Extraction de l' Iode.) This is a method of extracting iodine from the wet, unburned seaweed by treatment with a solution of caustic lime; the residue forms a very rich fertilizer. 2,000 w. La Levue Technique—Feb. 10, 1897. No. 11,-413. 30 cts.

JAPAN.

The Mineral Industries of Japan. None of the mineral products except coal and copper are important, although others are found. Information of the extent to which they are developed is given. 3,800 w. Nat Ass'n of Mfrs—Circ No. 11. No. 11,176. 45 cts.

LEAD.

Halkyn Mines. E. Ashton, Jr. Describes the development of the dressing plant of this lead mine. 2,500 w. Min Jour—Feb. 20, 1897. No. 11,314. 30 cts.

MANGANESE.

The Manganese Mines of Huelva. Carlos Sundheim. Describes locality and deposits and gives analyses and amount exported. 800 w. Am Mfr & Ir Wld—Feb. 12, 1897. No. 11,052. 15 cts.

METALLURGY.

Improvements in Mining and Metallurgical Appliances During the Last Decade. E. G. Spilsbury. Notes the many and varied improvements, progress in furnace practice, steel-making, copper production, gold, silver and lead, aluminum and nickel. Pres Address at the Chicago meeting of the Am Inst of Min Engs. 6,300 w. Ir Age—Feb. 25, 1897. No. 11,208. 15 cts.

NEWFOUNDLAND.

Newfoundland as a Field for Mining Investment. Alexander Dick. Reviews the mineral deposits of the island and concludes that there are vast possibilities as a mineral producing country. 1,900 w. Can Eng—Feb., 1897. No. 11,039. 15 cts.

ORE Dressing.

Ore Dressing. H. K. Landis. The methods and apparatus employed at the zinc mines of Southwest Missouri. A description of the geological formations in which the ore is found and the different systems of concentrating as illustrated in the better plants. Ill. 1,700 w. Col Eng —Feb., 1897. No. 11,067. 30 cts.

PETROLEUM.

Graphical Record of Borings for Petroleum. (Graphique d'un Sondage à Pétrole.) A graphical chart, of which the abscissas are times and the ordinates depths, thus giving ocular demonstration of the rates at which various portions of the work have progressed. 1,600 w. La Revue Technique—Feb. 10, 1897. No. 11,414. 30 cts.

TASMANIA.

Tasmania as a Mining Field. C. C. Longbridge. Information gained from the report of the Sec for Mines in Tasmania, calling attention to mines likely to prove of commercial value. 1,700 w. Min Jour—Feb. 20, 1897. No. 11,317. 30 cts.

TESTING.

See same title under Mechanical Engineering, Miscellany.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.

Apparatus for Lighting with Acetylene. Illustrated description of three new pieces of apparatus, designed both for the production of acetylene and for lighting therewith. Camp's and Mareschal's gas generators, and the Morison Lamp. From Revue Industrielle. 1,200 w. Sci Am Sup—Feb. 27, 1897 No. 11,214. 15 cts.

ACETYLENE.

The Storage of Calcium Carbide and Acetylene. Editorial from London Chemical Trade Journal. Gives classification and reviews the position showing that calcium carbide is safe, compressed acetylene gas practically so, while liquid acetylene requires care in handling. 1,800 w Pro Age—March 1, 1897. No. 11,322. 15 cts.

ASCENSION-PIPES.

Stoppages in Ascension-Pipes. Norton H. Humphrys. Considerations offered in the hope of aiding those having this trouble to contend with. 3,500 w. Jour Gas Lgt—Feb. 23, 1897. No. 11,348. 30 cts.

ELECTRICITY.

Some Facts Relating to Gas and Electricity. J. F. Seaman. Remarks the early effect of electricity upon gas stocks, and compares the central station and gas plant; storage battery and gas holder,

and other related matters. 2,200 w. Am Gas Lgt Journal—Feb. 15, 1897. No. 11,034. 15 cts.

Some Facts Relating to Gas and Electricity. Discussion of Mr. Seaman's paper at the annual meeting of the Ohio Gas Light Association. 4,500 w. Am Gas Lgt Jour—Feb. 22, 1897. No. 11,195. 15 cts.

EXPLOSION.

A Curious Gas Explosion. Irvin Butterworth. Read at meeting of Ohio Gas Lgt. Asso. Describes the circumstances of the explosion, which occurred May 12, 1896, at the Ohio Institution for Feeble Minded Youth, two miles from Columbus, O. 2,400 w. Am Gas Lgt Jour—Feb. 15, 1897. No. 10,035. 15 cts.

FUEL.

See Gas, under Electrical Engineering—Miscellany.

GAS Industry.

Inaugural Address of J. W. Helps. Read at meting of the Southern District Association of Gas Engs. and Mangrs., London. General review of topics of interest in the gas industry, especially regarding the establishment of experimental works, handling of coal, &c. 7,000 w. Gas Wld—Feb. 13, 1897. No. 11,158. 30 cts.

Inaugural Address of Mr. C. D. Lamson before New England Association of Gas Engineers. A review of the past year, considering most of the subjects of interest in the gas industry. 8,400 w. Am Gas Lgt Jour—March 1, 1897. No. 11,260. 15 cts.

GAS Manufacture.

Address by Prof. Charles F. Chandler, of Columbia College. Delivered at Madison Sq. Garden, Feb. 4. The popular fallacies which are held in regard to gas and gas companies. 4,200 w. Pro Age Sup—March, 1897. No. 11,323. 15 cts.

GASSING.

"Gassing." Its Prevention and Cure. Review of two papers bearing on gas poisoning which were read and discussed at the Liverpool Section of the Soc of Chem Ind. The papers were by Arthur Carey and Douglas Herman. 2,000 w. Jour of Gas Lgt—Feb. 9, 1897. No. 11,186. 30 cts.

HYDROCARBONS.

The Decomposition of Hydrocarbons by Heat. Dr. F. Haber and Herr H. Oechelhaeuser. Abstract translation of paper recently published in the "Journal für Gasbeleuchtung." The apparatus used is described with special methods of gas analysis devised for the work and experiments. 1,200 w. Jour Gas Lgt. Feb. 16, 1897. Serial. 1st part. No. 11,268. 30 cts.

ILLUMINATION.

Artificial Illumination. G. P. Lewis. Abstract of a lecture, briefly reviewing progress, considering thermal and lighting efficiencies, illuminating power and illuminating effect, &c. 1,500 w. Jour Gas Lgt —Feb. 16, 1897. No. 11,267. 30 cts.

ILLUMINATION.

The Development of Light from Gas Flames. Vivian B. Lewes. Paper contributed to the N. Y. Gas Exposition. Arguments in favor of the acetylene theory of luminosity. 6,000 w. Gas Wld—Feb. 6, 1897. No. 11,079. 30 cts.

PHOTOMETRY.

Address by Dr. Henry Morton, of Stevens Institute of Technology. Delivered at Madison Sq. Garden, Feb. 4. The Measurement of Light. 2,800 w. Pro Age Sup—March, 1897. No. 11,324. 15 cts.

SULPHUR.

On the Measurement of Sulphurous and Sulphuric Acids in the Products of Combustion of Illuminating Gases. M. Dermstedt and C. Ahrens, in Zeitschrift für Analytische Chemie. (Review of an article by Uno Collan, continuing researches and describing experiments made.) 2,000 w. Pro Age—Feb. 15, 1897. No. 11,118. 15 cts.

WELSBACH.

Public Lighting by the Welsbach System in Paris. M. Maréchal. Abstract of an article contributed to "Genie Civil," with comments from the "Journal de l'Eclairage au Gaz," giving a French gas engineering view of the requirements and possibilities of street lighting. 2,500 w. Jour Gas Lgt—Feb. 16, 1897. No. 11,265. 30 cts.

SEWERAGE.

CALCUTTA.

Calcutta Drainage Scheme. A brief outline of the history of the drainage, with sketch. 1,400 w. Ind Engng—Jan. 23, 1897. No. 11,264. 45 cts.

PUMPING.

Sewage Elevator. (Elevateur Hydro-Pneumatique.) Illustrated description of the Adams system of elevating and discharging sewage by automatic siphons operated by compressed air. 2,500 w. La Revue Technique—Feb. 10, 1897. No. 11,417. 30 cts.

TUNNEL.

The Milwaukee River Flushing Tunnel. Lawrence Fitch. Describes the successful plan brought forth by Mr. Benzenberg for overcoming the unhealthful condition of this stream. 1,100 w Yale Sci M—Feb., 1897. No. 11,124. 30 cts.

STREETS AND PAVEMENTS.

BRICK.

An Investigation of the Benefit of Structure on the Wearing Power of Paving Brick. Edward Orton, Jr. Gives results of investigations authorized by the Nat. Brick Mfrs.' Assn. Discussion follows. 4,000 w. Brick—Feb., 1897. No. 11,046. 15 cts.

Paving Brick for Country Roads. Thomas S. McClanahan. Discusses the need of good country roads, and the construction of brick roads. 1,800 w. Brick—Feb., 1897. No. 11,044. 15 cts.

Report of the Commission on Paving-Brick Tests. Edward Orton, Jr. Reports of tests by rattling, absorption, cross-

breaking, crushing, hardness, and specific gravity. 6,300 w. Brick—Feb., 1897. No. 11,047. 15 cts.

Standard Specifications for Paving-Brick Tests. Report submitted to the National Brick Mfrs.' Assn. by the committee appointed to investigate the question. 6,000 w. Munic Engng—March, 1897. No. 11,289. 30 cts.

SIDEWALKS.

Traveling Sidewalks and Their Advantages for Large Cities. (Stufenbahn und ihre Bedentung für den Massenverkehr in Gross Städten.) A description of the traveling sidewalk at the Berlin exhibition, with data as to power consumed and carrying capacity. 1,200 w. Glaser's Annalen—Feb. 1, 1897. No. 11,419. 30 cts.

SNOW Removal.

A Snow-Melting Machine. Illustrated description of a machine recently tested in New York. It is naphtha burning, and can be drawn by horses or propel itself. The melting capacity is estimated at about a cubic yard per minute. 900 w. Sci Am—Feb. 27, 1897. No. 11,211. 15 cts.

STREET Esthetics.

The Positive Value of Quiet and Beautiful Streets. J. W. Howard. Showing the elements that contribute to the value of city thoroughfares. Ill. 2,500 w. Eng Mag—March, 1897. No. 11,338. 30 cts.

STREETS.

Cross Sections of European Streets.—Robert Grimshaw. Shows the usage and provision made as regards street width and profile. Ill. 1,700 w. Munic Engng—March, 1897. No. 11,287. 30 cts.

WATER SUPPLY.

AIR LIFT Pumps.

Air Lift Pumps. Tests of Pohle Air Lift Pumps at the Rockford (Ill.) Water Works. Charles C. Stowell, in a paper read before the Ill. Soc. of Engs. & Survs. Description of trials and experiments continued over a period of nearly two years. Ill. 1,600 w. Eng News—March 4, 1897. No. 11,357. 15 cts.

AQUEDUCT.

Nashua Aqueduct; Boston Water Supply. A comprehensive description of the various parts of the scheme, with two-page engraving. 2,500 w. Eng News—Feb. 25, 1897. No. 11,237. 15 cts.

CAST Iron Pipe.

The Early History of Cast Iron Pipe. Extract from paper by Jesse Garrett, read at meeting of New England Water Works Assn. in 1896. Earliest accounts of cast iron and its first use for pipe. 1,500 w. Bul of Am Ir & St Assn—March 1, 1897. No. 11,256. 15 cts.

DENVER.

Notes on the Water Supply of Denver, Col. Information concerning some of the interesting parts of the system, with cuts of the new masonry dam. 1,800 w. Eng News—Feb. 25, 1897. No. 11,241. 15 cts.

FILTRATION.

An Improved Method of Filtration. Describes a system in operation in several cities of Germany that should be of interest to those struggling with the problem of purifying river water on a large scale for household and manufacturing purposes. 1,400 w. Cons Repts—Feb., 1897. No. 10,975. 45 cts.

LONDON.

London Water Supply. Editorial presenting the undesirability of intrusting the London County Council with the water supply. 1,500 w. Engng—Feb. 19, 1897. No. 11,303. 30 cts.

The Water Supply of London. W. H. Dickinson. A statement of the existing conditions and favoring the transfer of the undertakings into the hands of public authority. 9,000 w. Contemporary Rev—Feb., 1897. No. 11,002. 45 cts.

Water Supply of London and Other Large Towns. An examination of municipal water supplies as to quantity, purity, cost, &c. 2,400 w. Jour Gas Lgt—Feb. 16, 1897. No. 11,270. 30 cts.

MUNICIPAL Water Works.

The Terms of Purchase of Municipal Water Undertakings. List, prepared by order of London County Council, of the county boroughs in which the water works have been purchased, with the date, and remarks briefly setting forth the conditions and terms. 4,300 w. Jour of Gas Lgt—Feb. 16, 1897. No. 11,269. 30 cts.

ORGANISMS.

Detection of Organisms Affecting the Taste and Smell of Water by the Microscope. Abstract of an article in the Stevens Indicator by Dr. Albert R. Leeds explaining how examinations can easily be made. 1,000 w. Eng Rec—Feb. 20, 1897. No. 11,150. 15 cts.

PIPE.

Lead Pipe versus Iron. See Architecture, Plumbing and Gas Fitting.

RECORDS.

Prize Water-Works Blanks and Records. Information sifted from replies received in a prize competition, aiming to provide a method of keeping the accounts that is better than any one method now in use. 2,000 w. Munic Engng—March, 1897. No. 11,288. 30 cts.

RESERVOIR.

Reservoir No. 5; Boston Water Works. Illustrated description of interesting features of the work on this reservoir, with other information. 1,400 w. Eng News—March 4, 1897. No. 11,352. 15 cts.

Drainage Areas, Storage Capacity, and Compensation Water Discharged from Catchment Reservoirs. W. Watts. An epitome of paper read before the British Assn. of Water-Works Engs., with discussion. The difficulties met with by water authorities. 7,500 w. Jour of Gas Lgt—Feb. 23, 1897. No. 11,349. 30 cts.

SPRINGS.

Tracing the Water Supply of Springs. (Untersuchung einer Quelle in Herzegowinischen Karste auf ihren Ursprung.) An account of methods of tracing sources of water by salt, coloring matter, etc., as

compared with topographical investigation. 2,000 w. Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Jan. 29, 1897. No. 11,424. 15 cts.

WATER Tower.

A Steel Water Tower. Illustrated description of tower at Paris, Ill., a place of 12,000 inhabitants. 700 w. Eng Rec—Feb. 27, 1897. No. 11,263. 15 cts.

MISCELLANY.

FIRE Alarm.

See same title under Electrical Engng—Miscellany.

MUNICIPAL Plants.

See same title under Electrical Engineering—Light.

RESERVOIRS.

Diagrams for Estimating the Required Storage Capacities for River Drainage Areas. F. S. Bailey. Diagram useful for estimating the amount of water which a drainage area or reservoir will supply in extremely dry seasons. 400 w. Eng News—March 4, 1897. No. 11,358. 15 cts.

SANITATION.

German Maxims on School Sanitation. Reported by William Paul Gerhard. The result of several conferences held by a number of prominent German physicians, architects, sanitary engineers and school teachers. 1,800 w. Arch & Build—Feb. 6, 1897. No. 10,976. 15 cts.

The Sanitary Supervision of Shelters for the Homeless. F. J. Waldo. Abstract of a paper read before the Sanitary Inst., showing the necessity of bringing those places under the control of the local authorities. 1,200 w. San Rec—Feb. 19, 1897. No. 11,310. 30 cts.

TUNNEL.

The Design and Construction of a Small Steel Cylindrical Tunnel. H. D. Woods. Illustrated detailed description. 800 w. Eng Rec—Feb. 20, 1897. No. 11,151. 15 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

JAPAN.

An Era of Railroad Building. A few facts in relation to the present railway system in Japan, with brief forecast of its possibilities. 1,100 w. Nat Ass'n of Mfrs. Circ No. 11. No. 11,173. 45 cts.

LIGHT Railway.

The Barsi 2 ft. 6 in. Gage Light Railway. Everard R. Calthrop. The theory of the narrow gage light railway is explained; the history of this railway given, with discussion of traffic, rolling stock, permanent way and general information. Followed by discussion. 12,500 w. Jour Soc of Arts—Feb. 19, 1897. No. 11,318. 30 cts.

MONORAIL.

A Single-Rail Railway. Illustrated description of a monorail system, designed by Mr. Cailletet, possessing the conditions demanded for limited traffic in thinly populated districts, though not applicable to steam or other power traction. 1,500 w. Engng—Feb. 5, 1897. Serial. 1st part. No. 11,022. 30 cts.

RAILROAD Construction.

Mistakes and Improvements in Railroad Construction. George H. Paine. Showing the causes of the inferiority of American railway track and the considerations that must govern in improving it. 4,300 w. Eng Mag—March, 1897. No. 11,337. 30 cts.

SIBERIAN Railway.

Siberian Railroad Extension in China. The details of the arrangement for constructing and working a railway within Chinese territory. Also "Estimates of Siberian Railroad Traffic," and " Siberia as a Grain Exporting Country." 4,400 w. Cons Repts—Feb., 1897. No. 11,107. 45 cts.

TRACK Elevation.

Erection of the Park Avenue Viaduct, New York. Part first describes and illustrates the false work supporting temporary tracks and new centre girders. 1,500 w. Eng Rec—Feb. 27, 1897. Serial, 1st part. No. 11,262. 15 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

AXLES.

A New Method of Dressing Axles. See Car Wheels, below.

Divided Axles for Railways. (Ueber eine getheilte Eisenbahnachse.) A brief description of experiments with axles divided in the middle, with a loose sleeve coupling, to permit independent action of the wheels. 900 w. Glaser's Annalen—Feb. 1, 1897. No. 11,420. 30 cts.

BEARING.

A Roller Centre Bearing. Illustrated description of a centre bearing, designed to afford a slight amount of side motion, recently patented by Edward Cliff. 500 w. RR Car Jour—Feb., 1897. No. 10,991. 15 cts.

CAR.

A Private Car for the President of the United States. A project to construct a special car of the most approved design and from the best materials, to be subscribed for and built by the car-building and allied industries and presented to the nation for the use of the President. Names of the advisory committee are given and expressions of approval. 2,700 w. RR. Car Jour—Feb., 1897. No. 10,987. 15 cts.

Combination Car; B. & O. RR. Illustrated description of a combination baggage and passenger car recently built and put into service. 1,500 w. RR. Car Jour—Feb., 1897. No. 10,989. 15 cts.

Railroad Car Design. Archer Richards. Read before the Assn of American Draftsmen. A study of design and the various types of ornamentation. 2,500 w. RR. Car Jour—Feb., 1897. No. 10,990. 15 cts.

Steel Hopper Cars—Pittsburg, Bessemer and Lake Erie Railroads. Illustrations and

description, showing the method of construction which is to be employed in several hundred new steel cars. 1,300 w. Ry Rev—Feb. 20, 1897. No. 11,199. 15 cts.

CAR-WHEELS.

A New Method of Dressing Car Wheels, Axles, Etc. R. Atkinson. Read before the Canadian Soc. of Civ. Engs. Describes the working of iron in the cold state by means of machinery, and specially describes the Sibbald machine and process with trials. 2,000 w. Eng News—Feb. 25, 1897. No. 11,240. 15 cts.

Correct Gaging in Mounting Car-Wheels. Facts brought out in the paper presented by Mr. George Tatnall at meeting of N. Y. RR. Club, with editorial comment. 1,500 w. RR Gaz—Feb. 26, 1897. No. 11,244. 15 cts.

COUPLERS.

Defects in M. C. B. Couplers. Editorial comment on article by M. J. Lorraine considering the contour lines of this coupler. 1,300 w. Ry Rev—Feb. 13, 1897. No. 11,-087. 15 cts.

ENGINE.

See Locomotive, below.

LOCOMOTIVE.

Engines of the London, Chatham and Dover Railway. W. B. Paley. Illustrated description. This was the first line to use bogie express engines south of London. 1,800 w. Ry Wld—Feb., 1897. No. 11,090. 30 cts.

Locomotives at the Nuremberg Exhibition. (Die Lokomotiven auf der II. Bayrischen Landesausstellung in Nurnberg, 1896.) Description with numerous details of the important compound and other locomotives of the leading German builders. 2 articles—20,000 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 23 & Feb. 13, 1897. No. 11,402. 45 cts.

Smokestacks and Front-Ends for Locomotives Burning Lignite and Wood Fuel. Illustrated description of stacks used on the Union Pacific, made necessary by the kind of fuel used. 1,300 w. Eng News—March 4, 1897. No. 11,359. 15 cts.

Twelve-Wheel Compound Locomotive—Northern Pacific Railway. Dimensions, with description of an interesting design recently built by the Schenectady Locomotive Works for the Northern Pacific. 1,500 w. Ry Rev—Feb. 20, 1897. No. 11,197. 15 cts.

PLATFORM.

New Trojan Passenger Equipment. Brief description, with sections of buffer, of a recently introduced centre stem platform, with some novel features. 400 w. Ry Age —Feb. 19, 1897. No. 11,190. 15 cts.

SLEEPING Car.

An English Sleeping Car. Illustrated description of cars recently put upon the Northeastern Railway of England. Each passenger is given a stateroom. 3,000 w. RR Car Jour—Feb., 1897. No. 10,988. 15 cts.

SNOW-Flanger.

Snow-Flanger Operated by Air—Lake Shore and Michigan Southern Railway. Oscar Antz. Illustrated detailed description. 1,500 w. Am Eng & RR Jour—March, 1897. No. 11,254. 30 cts.

STEEL Cars.

Recent Designs for Steel Cars, Universal Construction Company, Chicago, Ill. Illustrated description of the improved Pennock car. 1,200 w. Eng News—March 4, 1897. No. 11,354. 15 cts.

UNDERFRAMES.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France. M. L. Tolmar. Part first classifies the cars, giving general description and maintenance of the general types. Ill. 2,700 w. Am Eng & R R Jour—March, 1897. Serial. 1st part. No. 11,253. 30 cts.

MAINTENANCE OF WAY AND STRUCTURES.

BRIDGES.

Different Methods of Numbering Bridges. Should All Waterways Be Numbered? Report of committee to the Convention of Ry. Supts., with discussion. 7,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,058. 45 cts.

The Mechanical Action and Resultant Effects of Motive Power at High Speeds on Bridges. Report of committee to Convention of Ry. Supts of Bridges and Buildings, with brief discussion. 1,000 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,063. 45 cts.

DEFLECTION.

See same title under Civil Engineering, Miscellany.

DRAWBRIDGE.

Methods of Locking Drawbridge Ends, and Under This Head Include Locking of Turn-Tables. Reports to Convention of Ry. Supts. of Bridges and Buildings, with diagrams and discussion. 3,300 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,059. 45 cts.

Opening of the N. Y. C. Four-Track Drawbridge and Viaduct in New York City. Illustrated description of this interesting work. 2,000 w. Sci Am—Feb. 27, 1897. No. 11,209. 15 cts.

FILL.

See same title under Civil Engineering, Miscellany.

PILE-DRIVER.

Best and Most Economical Railway Track Pile-Driver. Report of G. W. Hinman to the Convention of Ry. Supts. of Bridges and Buildings, with discussion. 2,400 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,064. 45 cts.

PLATE GIRDER.

See same title under Civil Engineering, Bridges.

RAILS.

Influence of Impact Upon Rails. (Zur Schienenstossfrage.) An investigation by Engineer Trautweiler, of Strasburg, upon the "hammer blow" action and pound upon rail joints. 5,000 w. Schweizerische Bauzeitung—Jan. 23, 1897. No. 11,445. 15 cts.

The Creep of Rails. (Ueber das Wandern der Schienen bei Eisenbahn-Geleisen.) An investigation into the causes of the creep of rails, with especial reference to the action of the locomotives in causing unequal creep. 2 articles, 10,000 w. 1 plate. Zeitschr Oesterr Ing u Arch Vereines—Jan. 22 and 29, 1897. No. 11,422. 30 cts.

RAILS and Splice Bars.

Specifications and Sections for Steel Rails and Angle Splice Bars, New York Central and Hudson River Railroad. Short description of track adopted, with the specification for rails and splice bars, recently adopted. 2,500 w. Am Eng & R R Jour—March, 1897. No. 11,252. 30 cts.

STATION.

Grand Trunk Railway Improvements. Drawings and description of some of the passenger stations and other important buildings erected during the past season. 1,700 w. Can Eng—Feb., 1897. No. 11,040. 15 cts.

Local Stations for Small Towns and Villages, Giving Plans of Buildings and Platforms. Report of comittee to convention of Ry. Supts., with numerous plans and discussion. 4,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,061. 45 cts.

The Revised Grand Central Station, New York City. Illustrated description of the extensive changes proposed, which will greatly increase the facilities for handling the immense business carried on. 1,800 w. R R Gaz—Feb. 19, 1897. No. 11,135. 15 cts.

TANKS.

Tanks, Size, Style and Details of Construction, Including Frost-Proof Protection to Tank and Pipes. Report of committee to Convention of Ry. Supts. of Bridges and Buildings, with discussion. 2,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,-062. 45 cts.

TRACK Circuit.

Observations on the Track Circuit from an English Standpoint. Arthur H. Johnson. A short description of the principles upon which such a circuit is operated. 1,500 w. R R Gaz—March 5, 1897. No. 11,360. 15 cts.

TRACK Elevation.

The Elevated Tracks of the New York Central Railroad in New York City. A series of views, with description of the work of raising the tracks to an elevated steel structure, and the various expedients which were resorted to in keeping the traffic and the new construction going at the same time. It is pronounced one of the most brilliant engineering feats on record. 2,800 w. Sci Am Sup—Feb. 20, 1897. No. 11,104. 15 cts.

TRESTLES.

Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burnouts. Discussion at sixth annual convention of the Assn of Ry Supts of Bridges and Buildings. 2,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,-055. 45 cts.

Protection of Trestles from Fire, Including Methods of Construction. Report of G. W. Hinman to the Convention of Ry Supts, with design and discussion. 1,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,060. 45 cts.

See Timber under Civil Engineering, Bridges.

VIADUCT.

The Coldremick Viaduct Disaster. Illustrated description of an accident on the viaduct of the Great Western Railway, England, while work was in progress for widening the line. 1,500 w. Eng, Lond—Feb. 19, 1897. No. 11,301. 30 cts.

SIGNALLING.

GRADE Crossing.

The Protection of Level Crossings. Notes on the minimizing of danger when a railway crosse. a road or footpath. Confined to the practice in England. 3,500 w. Engng—Feb. 5, 1897. No. 11,021. 30 cts.

INTERLOCKING.

Electric Interlocking the Block and Mechanical Signals on Railways. F. T. Hollins. Read at London Inst of Elec Engs. Briefly describes the systems of electric interlocking in practical use, dealing more in detail with the Sykes system. 4,500 w. Elec Eng, Lond—Jan. 29, 1897. Serial. First part. No. 10,980. 30 cts.

TRANSPORTATION.

CAR-FERRY.

Car Ferries of the Great Lakes of America. Illustrated description. 2,400 w. Eng, Lond. Feb. 5, 1897. No. 11,027. 30 cts.

EARNINGS.

Net Railway Earnings in 1896. A comparison with the previous year, with reasons for the less favorable showing, and tabulated statements. 1,500 w. Bradstreet's—Feb. 20, 1897. No. 11,144. 15 cts.

January's Poor Railroad Earnings. Table of gross earnings for 114 roads for Jan., 1897, comparing with a year ago and other statistics. 1,500 w. Bradstreet's—Feb. 13, 1897. No. 11,008. 15 cts.

EMPTY-CAR Mileage.

Should Mileage Be Paid on Empty-Car Movements? W. E. Beecham. From Ry Equipment Register. Discusses the return movements of empty cars, and gives what the writer considers the common sense way of disposing of the car. 1,800 w. Ry Rev—Feb. 13, 1897. No. 11,085. 15 cts.

FAST Running.

A New Record for Long-Distance Running. An interesting account of a fast run made from Chicago to Denver over the C., B. & Q. R. R. at an average speed of 54.27 miles per hour, with running time at an average of 57.53 miles. 1,700 w. R. R. Gaz—Feb. 26, 1897. No. 11,242. 15 cts.

INTERSTATE Commerce Act.

A Decade in Federal Railway Regulation. H. T. Newcomb. Abstract of paper

read at meeting of Am Economic Assn. Discusses the effect of the Interstate Commerce law. 1,000 w. Ry Rev—Feb. 27, 1897. No. 11,307. 15 cts.

Is the Interstate Commerce Act a Failure? From the Chicago Herald. Views of various officials. 1,400 w. Ry Rev—Feb. 13, 1897. No. 11,084. 15 cts.

RATES.

Unlawful Rates in Grain Transportation. The finding of the Interstate Commerce Commission in the alleged unlawful rates made by the Chicago Great Western Ry, with editorial comment. 3,000 w. Ry Rev—Feb. 13, 1897. No. 11,086. 15 cts.

TERMINAL Charges.

Terminal Charges. Editorial comment on paper of R. Price Williams, read before the Royal Statistical Society. 2,200 w. Engng—Feb. 19, 1897. No. 11,30[illegible]. 30 cts.

MISCELLANY.

ACCIDENTS.

Train Accidents in 1896. Tabular summary, with comments. 800 w. R R Gaz—Feb. 19, 1897. No. 11,137. 15 cts.

Train Accidents in the United States in January. Classified report of the more important accidents, with summary. 3,300 w. R R Gaz—Feb. 26, 1897. No. 11,243. 15 cts.

EDUCATION.

The Profession of the Railway and a Suggested Course of Training Therefor. George B. Leighton. Read before the N. Y. RR. Club. The author's ideas are presented and the paper followed by a lengthy discussion. 3,300 w. N. Y. RR Club—Jan. 21, 1897. No. 11,088. 45 cts.

EUROPEAN Railways.

European vs. American Railways. A comparison of advantages as shown in the report of Consul Monaghan, of Chemnitz. 700 w. Bradstreet's—Feb. 27, 1897. No. 11,251. 15 cts.

EXPOSITIONS.

Railway Exhibits at Berlin, Budapest and Nuremberg, 1896. (Die Eisenbahn-Fahrbetreibsmitte auf den Ausstellungen zu Berlin, Budapest und Nürnberg, 1896.) A critical examination, by H. von Littrow, of the locomotives exhibited, with illustrations of details. 10,000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Vereines—Feb. 5, 1897. No. 11,426. 30 cts.

RAILWAY LEGISLATION.

The Railway Problem. I. The Legislative Solution. Lloyd Bryce. II. A Mercantile View. James J. Wait. A review of the past and present condition of railroads is given by Mr. Bryce, with presentation of the difficulties, and the remedies suggested. Mr. Wait recommends educating the people to be honest with railroads, discusses existing conditions and suggests solution of the problem. 7,500 w. N Am Rev—March, 1897. No. 11,284. 45 cts.

STATE Ownership.

The Leasing of the Brazil State Railways. Statement of the wretched management of the government railways, and the decision to invite tenders from capitalists for the privilege of working them. 900 w. Trans—Feb. 12, 1897. No. 11,182. 30 cts.

SUBURBAN Traffic.

Electricity for Suburban Traffic. Remarks on Mr. Wallace's paper and the discussion that followed. 1,600 w. R R Gaz—Feb. 12, 1897. No. 11,015. 15 cts.

TAXATION.

Taxation of Railroads. Editorial discussion of the report of the special New Jersey Tax Commission. 2,000 w. R R Gaz—Feb. 12, 1897. No. 11,014. 15 cts.

TESTING.

The Chicago and Northwestern Testing Plant. E. M. Herr. Abstract of paper presented at the W. Ry Club. Description of tests. 2,800 w. R R Gaz—Feb. 19, 1897. No. 11,136. 15 cts.

WATER Supply.

Water Supply Stations for Locomotives. C. F. Street. From a discussion before the Western Ry Club. Discusses the use of the gas engine for pumping. 1,300 w. Ry Rev—Feb. 20, 1897. No. 11,198. 15 cts.

STREET AND ELECTRIC RAILWAYS.

GENERAL CONSTRUCTION.

ATHENS, Ga.

The Street Railway at Athens, Ga. Illustrated description of an interesting plant in which water power replaces steam. 900 w. St Ry Rev—Feb. 15, 1897. No. 11,116. 30 cts.

BILBAO.

Electric Tramway at Bilbao. (Elektrische Strassenbahn in Bilbao.) The line runs on both sides of the river Nervion from Bilbao to the harbor on the Bay of Biscay, a distance of about 9 miles. 1,200 w. Elektrotechnische Zeitschrift—Jan. 21, 1897. No. 11,432. 15 cts.

BUDAPEST.

The Budapest Electric Railway. Brief review of the Hungarian capital, especially its street railways, giving an account of the construction of the underground railway and its operation. Ill. 2,500 w. Trans—Jan. 29, 1897. No. 10,978. 30 cts.

ELEVATED Roads.

Some New Street and Electric Elevated Railroads in Europe. Condensed information of the electric line in Vienna, the Jungfrau, Edinburgh cable roads, Budapest Intramural railroad, Liverpool overhead railway and improvements in the electric roads of Lyons. 1,800 w. RR. Gaz—March 5, 1897. No. 11,361. 15 cts.

OVERHEAD Railway.

Extension of the Liverpool Overhead Railway. Illustrated detailed description.

2,200 w. Elec Rev, Lond—Jan. 29, 1897. No. 10,983. 30 cts.

SUBWAY.

Lease of the Boston Subway. The two bills introduced in the Legislature are explained, with a statement of the views of the commission, and the terms of the lease as finally adopted. 2,000 w. RR. Gaz—March 5, 1897. No. 11,362. 15 cts.

VERSAILLES.

Electric Tramways at Versailles. Illustrated detailed description. 1,000 w. Ry Wld—Feb., 1897. No. 11,092. 30 cts.

Electric Tramway at Versailles. (Les Tramways Electriques de Versailles.) Description, with map, of the local overhead trolley line recently opened at Versailles. 3,000 w. La Revue Technique—Feb. 10, 1897. No. 11,416. 30 cts.

VIENNA.

Electric Traction in Vienna. Illustrated description of the "Transversal" electric line of the Vienna Tramways Company. 1,000 w. Ry Wld—Feb., 1897. No. 11,091. 30 cts.

EQUIPMENT.

PLATFORM Buffer.

A Continuous Platform Buffer for Elevated Cars. Illustrated description of a new type of continuous platform buffer and automatic coupler, which has been in service on the Yonkers Branch of the New York Central, and is designed specially to meet the conditions imposed by a service on which the curves are very sharp. 600 w. RR. Gaz—March 5, 1897. No. 11,364. 15 cts.

LINE.

CONCRETE.

Concrete Work in Track Construction. Data on the cost of trench work in Minneapolis, with illustrations. 1,200 w. St Ry Rev—Feb. 15, 1897. No. 11,112. 30 cts.

ELECTRIC Conduit.

New Electric Conduit Lines in New York. Illustrated description of proposed work for the extension of this system, with editorial. 1,600 w. RR. Gaz—March 5, 1897. No. 11,363. 15 cts.

UNDERGROUND Trolley.

Underground Trolley, Cirla System. (System Cirla für unterirdische Stromzufuhrung bei elektrischen Strassenbahnen.) Illustrated description of an Italian electric tramway system with underground conductor and successive surface contacts. 1,000 w. Elektrotechnische Zeitschrift—Jan. 14, 1897. No. 11,429. 15 cts.

POWER.

COMPRESSED Air.

The Hardie Compressed Air Motors. Herman Haupt. An effort to answer some prominent objections. Also test of a compressed air reservoir taken from a Hardie motor after having been in use two years. 3,500 w. Sci Am Sup—Feb. 20, 1897. No. 11,105. 15 cts.

ELECTRIC Traction.

Electricity on the Manhattan Elevated Railways. The probability of electric propulsion on the elevated railways is discussed. 1,600 w. Elec Wld—Feb. 27, 1897. No. 11,258. 15 cts.

Practice in Electric Railway Power Distribution in Eastern Massachusetts. Deals with work actually done on some of the lines, with nearly every variety of problem in electric feeding and the solutions adopted. 4,000 w. St Ry Rev—Feb. 15, 1897. No. 11,114. 30 cts.

WATER-POWER and Electric Traction.

A Water Power Developed for Electric Railway. Albert Phenis. A description of the plant at Athens, Ga. 1,300 w. Mfrs Rec—Feb. 12, 1897. No. 11,004. 15 cts.

MISCELLANY.

ELECTRIC Railway Operation.

Comparative Economy in Electric Railway Operation. Charles H. Davis. Claiming that true economy lies less in the saving of coal than in the saving of wear and labor. 3,300 w. Eng Mag—March, 1897. No. 11,339. 30 cts.

FARES.

The Reduction in Street Car Fares. It is asserted that not only has the price of carfares been reduced, but that no other article in common use has been as greatly reduced. Specific cases show a surprising increase of service, without increase of compensation. Diagrams show the extension since 1887. 2,800 w. St Ry Rev—Feb. 15, 1897. No. 11,113. 30 cts.

OPERATING Expenses.

Operating Expenses of Connecticut Roads in 1896. Information from the annual report of the Railroad Commissioners of Connecticut regarding the earnings and expenses of the street railways. 1,500 w. St Ry Rev—Feb. 15, 1897. No. 11,115. 30 cts.

RAPID Transit.

Rapid Transit. The Report of Through Train Service Across the Brooklyn Bridge. Extracts from the report and drawings, showing the plans proposed. 5,800 w. Eng News—Feb. 18, 1897. No. 11,131. 15 cts.

Rapid Transit. Report of the committee of experts favorable to the idea of Brooklyn elevated and trolley cars crossing the bridge. Plans for the surface cars and L trains are given. 800 w. Elec—Feb. 10, 1897. No. 10,992. 15 cts.

REPAIRS.

Repair of Electric Railway Machinery. Describes methods and appliances for comparing two motors in order to determine their adaptability for mutual operation. 1,700 w. Am Elect'n—Feb., 1897. No. 11,-223. 15 cts.

TESTING Wagon.

Testing Wagon of the Electrical Department of the City of Munich. (Der Kabelmesswagen der städtischen Elektricitätswerke in München.) An illustrated description of a portable testing apparatus, forming a complete laboratory on wheels. 1,500 w. Elektrotechnische Zeitschrift—Jan. 21, 1897. No. 11,431. 15 cts.

BOOKS OF THE MONTH

Bell, Louis, Ph. D. Electrical Power Transmission; A Practical Treatise for Practical Men. The W. J. Johnston Company, New York. 1897. Cloth, $2.50.

The author sets forth in the preface his intent of covering present practice, in such a way that "the man, engineer or not, who desires to know what can be accomplished by electrical power transmission, and by what processes the work is planned and carried out," may acquire this knowledge readily. The extreme technical side of the subject is therefore not allowed to obscure the practical side. Typical apparatus is described, rather than special and mutable forms. As a preliminary to the discussion of electric transmission, all other modes are discussed and comparisons are made which indicate the legitimate use of each. The modes of dederiving formulæ which are in common use are very little considered; but the use and applications of these rules are clearly set forth. The book is handsomely printed and well illustrated.

BOOKS RECEIVED.

The Journal of the Iron and Steel Institute, Vol. L. Edited by Bennett H. Brough, Secretary. E. & N. F. Spon, Limited, London; Spon & Chamberlain, New York. Sold also at Offices of the Institute, London. 1897.

Report on Public Baths and Public Comfort Stations of New York City. Published by the Mayor's Committee on Public Baths and Public Comfort Stations: New York City.

Brooks, Robert C. Municipal Affairs. Issued at quarterly intervals. Vol. 1, No. 1. March, 1897. A Bibliography of Municipal City Conditions. Reform Club Committee on Municipal Administration. New York, 1897. Paper. First number, 50c.; later numbers, 25c.

Annual Report of the Board of Regents of the Smithsonian Institution, to July 1, 1894. Government Printing Office, Washington. 1896.

Ries, Heinrich. The Pottery Industry of the United States. Department of Interior, U. S. Geological Survey, 1895-6. Government Printing Office, Washington, D. C. Paper.

Ladd, Loren G., Commissioner of Public Works, and Perry, Fred G., Assistant Commissioner. Annual Report of the Board of Public Works of the City of Pawtucket. John W. Little & Co., Pawtucket. 1897.

Wales, Herbert, President of the Canadian Society of Civil Engineers. Address Delivered at the Annual Meeting, January 13, 1897. Paper.

Exports Declared for the United States. Returns from Consular Districts for Quarter Ended September 30, 1896. Supplement to Consular Reports No. 196 (January, 1897). Government Printing Office, Washington. 1897. Paper.

Thompson, Almon D. Fifth Annual Report of the Department of Public Works of the City of Peoria, Ill., for the Year Ending December 31, 1896. Paper.

Francis C. Moore, President of the Continental Fire Ins. Co., New York. How to Build a Home; being Suggestions as to Safety from Fire, Safety to Health, Comfort, Convenience, Durability, and Economy. Published by the Author. 1897. Paper, 50c.

Report of the Board of Irrigation Survey and Experiment for 1895–1896 to the Legislature of Kansas. The Kansas State Printing Company, Topeka, Kansas. 1897. Cloth.

BOOKS ANNOUNCED.

Andrews, T. Microscopic Internal Flaws Inducing Fracture in Steel. Spon & Chamberlain, New York. 1897. Paper, 40c.

Bell, L. Electric Transmission of Power. The W. J. Johnston Co., New York. 1897. Cloth, $2.50.

Gerard, Eric. Electricity and Magnetism. The W. J. Johnston Co. 1897. Cloth, $2.50.

Langdon, W. E. The Application of Electricity to Railway Working. Spon & Chamberlain, New York. 1897. Cloth, $5.

Lord, N. W. Notes on Metallurgical Analysis. Chemical Publishing Co., Easton, Pa. 1897. Cloth, $1.25.

Steinmetz, C. Proteus, and Berg, Ernst, J. Theory and Calculation of Alternating Current Phenomena. The W. J. Johnston Co., New York. 1897. Cloth, $2.50.

Stillman, T. B. Engineering Chemistry: A Manual of Quantitative Chemical Analysis for the Use of Students, Chemists, and Engineers. Chemical Publishing Co., Easton, Pa. 1897. Cloth, $4.50.

Storer, Francis Humphreys, and Comey, Arthur Messinger. A Dictionary of Chemical Solubilities; Inorganic; A New Improved Edition of Storer's "Dictionary of Chemical Solubilities." By Arthur Messinger Comey, Easton, Pa. 1897. Cloth, $5.

Bennett, Frank M. The Steam Navy of the United States; A History of the Growth of Steam Vessels of War in the United States Navy, and of the Naval Engineer Corps. Warren & Co., Pittsburg, Pa. 1896. Cloth, $5; half Turkey morocco, $7.50; full Turkey morocco, $10.

Kinealy, J. H. Low-Pressure Steam-Heating Charts for the Use of Architects, Surveyors, Contractors, and Steam Fitters. Spon & Chamberlain, New York. 1897. Cloth, 80c.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

"Flowed" Steel.

THE illustration here presented shows an example of a new departure in the art of making alloys or mixes for high grade steel castings. Something over a year ago the Aultman & Taylor Machinery Co., of Mansfield, Ohio, started to have a series of experiments made with a view to obtaining a mix for steel castings which should equal, if possible, in its chemical and physical properties, the best boiler-plate steel. After a long series of expensive trials a mixture was discovered which gave remarkable results.

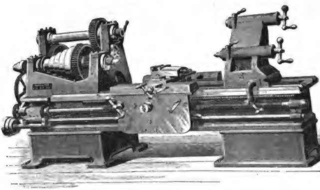
A HEADER MADE OF FLOWED STEEL.

Owing to the high price of some of the alloys used, castings made by this process are very expensive, costing from 6c. to 8c. a pound in the rough, but for the particular purpose for which they are designed they are much cheaper to use, even at this price, than the ordinary steel castings at less than half the cost per pound.

Castings made by this "flowed" steel process are absolutely free from flaws, defects or blowholes, and are uniform in their texture throughout. Every piece of the metal is guaranteed to have an elongation of not less than 25%, and a reduction in area of not less than 50%, with an 8-in. test piece. Some of the samples have shown an elongation of 31% and a reduction in area of over 60%. The metal can be worked cold as well as, or better than, steel plate.

The basis of the mixture is open hearth steel of the finest quality. "Flowed" steel is used by the Aultman & Taylor Machinery Co. in manufacturing crossboxes, flanges, etc., in all their Babcock & Wilcox type of boilers. Where this type of boiler is manufactured by them for a working pressure exceeding 225 lbs. to the square inch, they also use it in the "headers" into which the boiler tubes are expanded.

The figure shows a header of this type, six tubes high. It will be noticed that the header for a space of two tubes in length has been flattened out and then bent back on itself. It is extremely doubtful if that experiment can be succesfully performed on a steel forging of any description. The remarkable physical properties of the metal are further exhibited in a series of photographs shown by the firm. The borings and turnings, which form the subjects, were photographed just as taken from the scrap pile, without any effort to obtain samples out of the ordinary, and they evidence most unusual tenacity and elasticity.



A NEW DOUBLE-SPINDLE LATHE. FRONT VIEW.

A header made in this manner possesses two very material advantages over a header made of forged steel. First: there is no weld to be made, which avoids one great element of weakness in forged headers. Second: the walls of the header can be thickened at will where the strain incident to its use requires greater strength than at other points. This is especially desirable at all corners in the header, as the strains are greatest there. With the forged-steel header, the process of manufacture thins the metal at these very points of greatest strain, or an exact reversal of what should pertain to give best results.

The same holds true in regard to crossboxes or saddles on the drums of boilers for the reception of the nipples connecting the drums to the headers.

In this connection we have been requested by the Cahall Sales Department, Pittsburg, to state that "flowed" steel is a special mix of open hearth steel manufactured under a secret formula which belongs to them alone; and the knowledge of its preparation is in the possession of no one except the Penn Steel Casting & Machine Co. of Chester, Pa. Hence, "anyone offering either headers, crossboxes, or flanges made of 'flowed' steel, is doing so with intent to deceive the public." The Penn Steel Casting & Machine Co. also state, in a letter addressed to the manufacturers: "we consider the special mixture for flowed steel we are making for you, your property of which you have the sole right, and that we never have nor never will furnish flowed steel to anyone but yourselves unless authorized by you. Neither will we give to anyone any information as to the formula under which this special mixture is made."

A New Double-Spindle Lathe.

MESSRS. DIETZ, SCHUMACHER & BOYÉ, Cincinnati, O., have recently introduced an improved lathe which solves the problem presented to the man, three-fourths of whose lathe work can be done on a 26-inch lathe, but who occasionally has a job of boring or turning which requires more swing in order to handle it. The usual solution of such a problem is "raising blocks" for head and tail stock. These are by no means satisfactory. It takes much time to put them in and remove them; they usually make trouble with the feed arrangements; when the large work is put on a lathe so raised, the rest must be drawn out so far as to render the tool very poorly supported; and a lathe once raised will spoil the alignment in both positions and will never be satisfactory again.

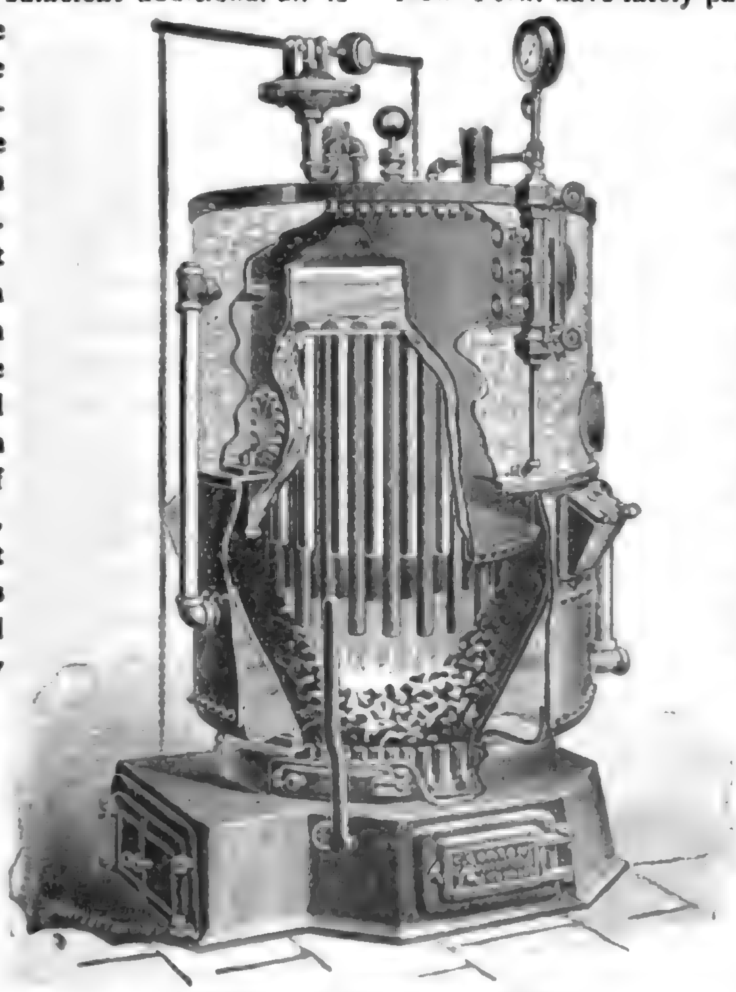
As shown in the front view, the lathe is adapted for use on the smaller work, and is no different from the regular 26-inch lathe of the same make, except that the tail stock is somewhat heavier than it otherwise would be. When the larger work comes along, it is only necessary to connect up the gears by pressing the lever down, and putting a suitable face-plate or chuck on the upper spindle and placing the work on the upper pair of centers; an extra tool post being provided for bringing the tool up level with the center if this is desired, though it is, of course, not always necessary.

This lathe is much better for the range of work within its capacity than a 26-inch lathe would be with raising blocks, while it is also more convenient and efficient for the smaller work than a 44-inch lathe would be, other things being equal. Circulars and further information will be gladly furnished by the makers on application.

It Burns the Smoke.

THE tendency of soft coal to deposit soot and unconsumed carbon on the heating surface of the boiler in which it is used has given so much trouble, that its use in house-heating boilers has been rendered far from being economical, in spite of its cheapness. The trouble is caused by imperfect combustion, and ceases when perfect combustion is attained. Take, for example, the mechanical stoker now used to a large extent with power boilers. By its use even the finest soft coal can be continuously fed into the fire box without visible smoke from the chimney top. Complete combustion is obtained by feeding the coal to the furnace more uniformly than it is usually fed by an engineer. (See an article on Mechanical Stoking in the February '97 number of the ENGINEERING MAGAZINE.)

The Gorton Soft Coal Boiler, here illustrated, is especially constructed to burn the soft coal which is so abundant in the southern and western states. Instead of using a mechanical device for supplying coal to the fire-pot, this work is accomplished by gravity. The coking chambers and coal reservoirs are located between the lower outer surface of the boiler, and the upper part of the water-leg, so that the coal feeds down into the fire just as it is required. The fire-pot is so constructed that sufficient additional air is drawn through the fingered ring at the lower edge of the coking chambers to ignite the gases arising from the coking process. This gives perfect combustion, which means economy in fuel, and prevents the deposit of soot and unconsumed carbon on the heating surface of the boiler and, further, makes use of that part of the fuel which is wasted when soft coal is used in ordinary fire-pots. This boiler is manufactured by the Gorton & Lidgerwood Co., New York, and they claim that it is the only boiler that will burn soft coal by coking it before feeding it down on the fire, thus insuring the greatest economy and reducing the cost of running below that of any other heating boiler on the market.



A SOFT-COAL BURNING BOILER.

A Large Rand Compressor.

A RECENT issue of a Canadian paper contains an interesting account of the christening and starting up of a large Rand Compressor recently installed in the Le Roi mine at Rossland, B. C. The compressor will be known as the "Senator," and is to be used for running all the pumps and hoists at the mine in addition to operating 40 drills. It is described as a beautiful piece of mechanism in every detail of its construction, and is fitted with the latest type of mechanical air-valves, automatic governors, etc. It has the distinction of being one of the three largest compressors in use in the northwest. The machine is of the latest improved type, with Corliss compound condensing engine; steam cylinders 22 × 40 × 48 inches stroke; air cylinders, 22 × 34 × 48 inches stroke, with intercooler. The Rand Drill Company, 100 Broadway, New York, were the builders.

The "Centaur" Porous Terra-Cotta Brick.

THE well-known firm of Henry Maurer & Son, New York, have lately patented and introduced to the building trades at home and abroad a terra-cotta brick which has special claims upon the interest of those concerned with the problems of fire-proof construction. It is represented to be absolutely fire-proof, and though seemingly as hard-burnt as a front building brick, and as dense, its porosity is equal to, if not exceeding, that of hardwoods. Nails have been driven into this brick its entire length as closely as they could be, without causing either splitting or chipping; and the tenacity inherent in this material is such that it becomes as

difficult to draw them as when driven into hard-wood. It is nearly impervious to the weather and is particularly adapted for partitions, furring, roofing, column- and girder-covering in all buildings. It can also be employed in connection with common red brick, in any and all work where nailing is requisite.

From these qualifications it must readily occur to every carpenter, mason, or contractor what a great saving in time, labor and expense the use of this brick involves. Samples and prices will be furnished by the makers on application.

Long Distance Transmission.

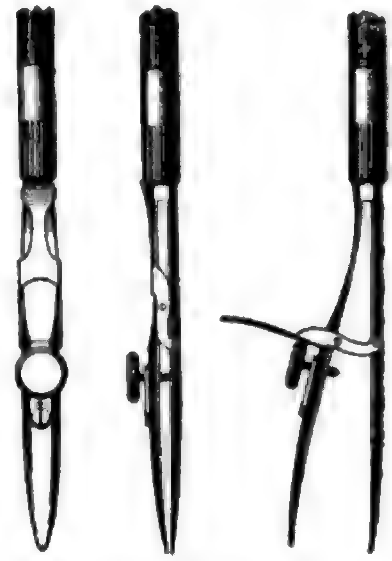
THE success of long-distance electrical transmission can be safely gaged by the experience of those actually operating a plant; and in this connection our readers will be interested in the following extract from a letter written by Mr. John J. Seymour, President of the San Joaquin Electric Company, operating the San Joaquin River-Fresno transmission, to the General Electric Company, which installed the plant. He says

"It affords me great pleasure to write you regarding the successful operation of the long distance transmission plant installed for our company. The entire plant as furnished has been in practical operation for a period of several months. The 35 miles transmission has given us no trouble whatever. Our load at present consists of 145 arc lights, 5000 incandescent lights, and 410 H. P. in motors, the latter including 180 H. P. for the Sperry flour mill and 75 H. P. for the city pumping-plant. All of the machinery doing this work has worked with perfect success from the start."

"The incandescent lights have most of them been newly wired in, thus enabling us to properly balance the load and the regulation has given us no trouble whatever. During extensive tests, it was impossible to find more than two volts variation between any lamps on the system. Lights so furnished seem to me to be better than incandescent lights usually furnished in San Francisco and other cities of the State."

A New Ruling Pen.

MESSRS. THEO. ALTENEDER & SONS, Philadelphia, have just introduced a ruling pen which will find glad welcome among draughtsmen the world over. It is what they call "Alteneder's Lever Ruling Pen," and its notable improvement consists in the fact that it may be easily cleaned without altering the line-adjustment, an advantage which every practical draughtsman will appreciate.



A NEW RULING PEN.

The pen is made in one piece, with the upper blade in the form of a spring, the action of which is such as to constantly press the points together. The adjusting-screw is fitted to the upper instead of the lower blade (as is usual), and merely bears against the inner surface of the latter; thus separating the points to obtain the desired width of line.

A lever, having parallel arms, is pivoted to the lower blade, and is provided with a bar connecting the two arms and located between the blades. When the lever is lifted, the bar raises the upper blade and holds the points apart for cleaning.

A Change of Name.

THE corporation heretofore doing business in New Jersey, New York and elsewhere under and by the name of "W. A. Cook & Bro.'s Co." has recently, pursuant to the laws of the State of New Jersey, changed its corporate name under which such corporation was and is organized, to that of "LAMBERT HOISTING ENGINE CO.," under which name it will continue to do business in the same line as heretofore.

THE

ENGINEERING MAGAZINE

VOL. XIII. MAY, 1897. No. 2.

THE INCREASED CONFIDENCE IN AMERICAN RAILROAD SECURITIES.

By Thomas F. Woodlock.

FOR some years past attention has been given by investors to the fact that within a comparatively short time a large amount of American railroad bonds, bearing high rates of interest,—that is, six, seven, and eight per cent., and in a few cases even more,—would mature. Stockholders of roads on which large quantities of high-rate bonds were outstanding have naturally looked forward to the time when they could pay off these onerous loans, borrowing the money on better terms, but still leaving a mortgage on the property, or raising the necessary amount in other ways. The essential point in their minds, and in the minds of all who considered the matter, has been the fact that a considerable annual saving could be made by paying off the high-rate loans.

Within the last few weeks two great companies, the Lake Shore and the New York Central, have effected an operation by which they refund at three and a half per cent. all the funded debt now outstanding, consisting of high rate bonds, maturing at various dates in the near future. As the operations involve the issue of $150,000,000 of three and one-half per cent. bonds, and as the companies are among the most prominent in the country, it is only natural that the attention of everyone should have been attracted, not merely to the scheme in so far as it concerned these roads, but to the general principle underlying it and the possibilities of its application to other railroads. The announcement of the refunding plans caused at once the liveliest discussion of the position of other representative roads, and some interesting compilations were made, showing how the principal railroads of the country stood with regard to their bonded debt, and the possibili-

ties of saving by the speedy replacement of high-rate bonds by bonds bearing a rate of interest commensurate with present monetary conditions. Perhaps the most perfect compilation of the kind was made by the *Commercial and Financial Chronicle*, which printed a list of railroad bonds maturing between now and 1905, amounting in the aggregate to more than seven hundred millions of dollars. These bonds now bear interest at rates from five per cent. upwards, and the *Chronicle* showed that, by refunding them on a four per cent. basis, the annual saving in interest would amount to no less than $16,678,690, while, if they were refunded at three and one-half per cent., the saving would be $20,232,138.

The whole subject is one of great interest and importance. It is evident, of course, that there has been everywhere a general appreciation of credit in the last few years. The process has been very marked in the case of British railroads. To mention one example, it is enough to say that only a little more than ten years ago London and Northwestern four per cent. debenture stock used to sell well below 120, whereas its present three per cent. debenture stock has been quoted at almost that price. Whatever appreciation has taken place in railroad credit here is to be accounted for, at least in part, by the general appreciation of high-class credit all over the world, but mainly, of course, by betterment in the position of individual railroads themselves.

A generation ago all our railroads had to offer very considerable inducements before they could secure the capital needed for construction or improvement. High rates for money had then to be offered, because of the highly speculative character of the undertaking, and because profits in all industries in those days were larger than they are now. The railroads had to borrow money at almost any rate, and only too often was it necessary to make large bonuses of stock to insure the placing of bonds. The high-rate bonds outstanding on our railroads to-day are a relic of the time when the building of railroads was as much a speculation as is a certain class of wild-cat gold mining to-day.

Many railroad systems of this country have passed through their time of trial, and now are recognized institutions of stability and value. Certainty of return therefrom places their securities on a high level in the eyes of investors, and what are known as "gilt-edged" mortgage bonds of a few railroads have for some time commanded high prices.

The Inter-State Commerce report for the year ending June 30, 1895, gives the following table of railroad bonds outstanding on which four per cent. interest or upwards was paid during that year. A large

number of bonds did not receive anything, and some received less than this, owing to the poor circumstances of the railroads themselves, pending re-organization, etc.

Bonds paying 4@5%,	$1,087,404,229
Bonds paying 5@6%,	990,957,044
Bonds paying 6@7%,	500,872,724
Bonds paying 7@8%,	343,493,020
Bonds paying more,	42,776,684
Total,	$2,965,503,701

Our railroads thus have an opportunity within the next few years —for long-term bonds were not fashionable when most of the high-rate bonds were put out—to pay off a very large amount of debt bearing high rates of interest. The great question is: On what basis can they borrow fresh money for this purpose?

In order to understand the rather peculiar position of our railroads, and thereby enable ourselves to answer this question, it is worth noting that in England debentures or obligations which are a first charge (or almost a first charge) on railroad property sell at pretty nearly one price, without much regard to the dividend paid by the road. The difference in yield between the debentures issued by a road which pays six or seven per cent. on its capital stock and those of a road which pays only about half this amount does not amount to much more than one-eighth of one per cent., the total yield to the investor varying from two and one-half per cent. to two and five-eighths per cent.

Here there is no such uniformity. Railroad bonds sell strictly according to the apparent general merits of the property which issues them, and yet very striking anomalies can almost always be found by taking a little trouble. A first-mortgage bond on an American railroad is not a security as yet of standard or fixed value, as is a debenture on a British road. In short, it is impossible to say that railroad credit in this country is on this, that, or the other basis of yield. The credit of Lake Shore and New York Central is seemingly on a three and one-half per cent. basis, but it is very doubtful if many other roads could be named whose credit is as high, and it would be still more difficult to give any one reason why the credit of a good many roads should not be as good in the eyes of the investor as that of these roads, as far as their first-mortgage bonds are concerned. The following considerations seem to bear upon the whole question:

(1) The railroad industry in this country has been, and still is, as it were, in a molten condition, although there are signs that it is finally settling into permanent shape. That it is not, as it is in Eng-

land, a solid, settled industry is obvious, and for a score of reasons. To mention one,—England was settled in every part before the railroads were built, while in this country the railroads practically settled the land. The railroads have been pioneers to a large extent, and, as they opened up fresh territory, conditions of population, commerce, and even daily existence changed, so that old methods, old principles, and old rules were of no use. There was never any equilibrium in the business of distribution and transportation, and it was obvious that there could not be, as long as railroad construction went on to a large extent year by year.

(2) Such conditions, or, rather, such change in conditions, completely upset original calculations, and brought carefully-constructed plans to nought, with the result that properties which seemed settled and prosperous were left high and dry by the changing tide of traffic under the influence of new territories opened up and new routes formed.

(3) In addition to all these things, the railroads have had to combat a process of continuous attack, first in the State legislatures, and finally in congress, which, as everybody knows, has had the effect at times of entirely demoralizing the conditions of business, without benefit to anyone but a few unscrupulous shippers and traffic managers. It is unnecessary to lay stress upon this aspect of the case, as a recent decision of the supreme court has brought it freshly before everyone's mind. This has hurt certain roads more than others, and thus has tended to accentuate already existing differences.

(4) Great Britain had its own experience of the railroad kings and the railroad wreckers, which was probably instructive, if short. Is it necessary to do more than allude to the part played in our railroad history by the promoter of railroad swindles of all kinds? One has only to look a little below the surface of the re-organizations of the last three years, completed and pending, to see the handiwork of the railroad thief in his various forms.

(5) The rarity of dividends on American railroad stocks has always stood as a warning to the careful investor in bonds. It has been, perhaps, one of the strongest factors making for the most careful discrimination on the part of investors as to the individual merits of each property. Naturally it has tended to prevent people in general from looking upon railroad mortgage bonds as of anything like uniform merit The natural effect of this has been to prejudice the good bonds, because the taint of those securities which were not good had to spread in some extent to all others. Default, occurring, as it has done, at short intervals, has acted as a perpetual deterrent to the investor in railroad bonds. Default on fixed obligations has been a great rarity in Great Britain these many years.

(6) Last of all, there are to be mentioned, of course, the unfortunate currency conditions that have existed in this country since the war. They are known to everybody. There is not the least doubt that these conditions have prevented railroad investments in this country from selling as high as they would otherwise have sold on their individual merits. Only of late years has the practice of making gold bonds become at all general, and, even in cases where gold bonds have been issued, there has often been question as to whether the railroad company would really fulfill its contract, in case the contract was of value only to the holder of the obligation. All of which has tended to foster discrimination.

These are a few of the reasons why the credit of our railroads has not been more uniform, and has not more nearly approached that of railroads in Great Britain and the other old countries. It is evident also that these are reasons for doubting that the rate of interest fixed by Lake Shore and New York Central in their refunding schemes is one that is likely to be attained by many roads in the very near future.

The fact of the matter is that our railroads have only just found what might be called a solid foundation on which they can build for the future. There is every reason to believe that decline in rates will be slower in the future, if it occurs at all, and that, unless there should be a fresh outburst of railroad construction,—which is not at all likely,—natural causes will shortly check it permanently. We have had for about four years a combination of panics, depression, and poor crops, which have severely tried every railroad in the country. It is not reasonable to suppose that, unless we are on the verge of a political and industrial revolution, the country will have to face such a combination of circumstances again for a long time.

Now, the point of this is that the principal railroads of the country have turned the corner. They may legitimately expect to do a larger business in the future than they have done in the last three years. Very few people, moreover, realize the extreme importance of the lessons of economy that have been learned by the railroads during this time of trouble. The whole railroad industry in this country may be said now to be, for the first time in its existence, upon something like a broad, solid, and scientific foundation. Honesty and efficiency of management are likely to show tangible results in the future.

It is evident from this that, as time goes on, there should be greater uniformity apparent in first-class American railroad credit. We may expect to see something like a standard, such as exists to all intents and purposes in England, and we should look for representa-

tive railroad bonds to conform rather closely to that standard. A settlement of our currency troubles would hasten immensely such a consummation, because it would effect direct connection between our investment markets and European capital, in place of the intermittent and altogether unsatisfactory connection that has existed for the last few years. These things, however, are matters that take time and hard work. Meantime bonds mature by the hundred million. What is the standard of credit to be?

If the line of reasoning adopted so far be correct, it is evident that it is not wise to attempt to fix a standard of credit now, for the future, by the issuing of very-long-term bonds at a rate sufficiently high to enable them to be floated at the present time. It is not by any means certain that many entirely solid roads whose bonds will mature in the next few years could refund them at the present time on a three and one-half per cent. basis. Probably a few could do so, but, on the other hand, many could not. It might be necessary for some roads to refund on a four per cent. basis, and even this might not suffice in the case of others. Is there not at least a good chance that ten years from now the credit of solid railroads in the country will be on a good deal better than a three and one-half or four per cent. basis? By that time, if the signs of the times are not deceptive, there will have gone on, in the case of all of our great systems, a process of steady growth and conservative upbuilding which will have had the effect of removing from the region of the speculative into the region of strict investment many securities now somewhat despised.

Hence, anticipation of maturity of bonds on the principle of the plans announced, by the issue of a long-term bond now on such terms as will induce existing owners of the high-rate bonds to convert before maturity, may not be, on the whole, a wise operation for other roads. Lake Shore and New York Central stockholders may some day regret that the directors placed a 100-year mortgage on the property bearing so high a rate as three and one-half per cent. It is possible that, when the great bulk of the outstanding sevens mature, these very three and one-half per cent. bonds may be selling on not far from a three per cent. basis. The possibilities, in fact, seem to lie chiefly on the side of an advance in railroad credit from its present level, and this is the chief argument against any hasty conversions before maturity. It is doubtful if anything will be lost by stockholders in any honestly-managed American road by waiting until almost the last moment before taking steps to refund maturing bonds.

The ideal position for stockholders of a railroad, as far as its bonds are concerned, is to have these bonds sell at not much above par, and the rate of interest paid should be such as to keep bonds about at this

level. Why should it be a source of gratification to the owners of a property to have its obligations quoted at high premiums, when this fact simply shows that the company is paying a higher rate of interest than it really needs to pay? This rather suggests a solution of the refunding difficulty which would, perhaps, secure to the owner of railroad properties the maximum of benefit from the refunding of their high-rate obligations.

Let a railroad company which has bonds maturing at intervals beginning next year go upon the principle of dealing with each batch as it comes due, on the best terms possible. Let it make one large refunding mortgage, designed to take the place of the maturing bonds, which mortgage should be made for a period of not more than twenty-five years. It should be made at no fixed rate of interest, but should be issued from time to time in the amounts required, at any rate of interest that might be determined upon by the directors. Thus the directors would be in a position to secure to the stockholders all the advantages arising from improvement in the credit of the property. As it would be necessary to issue some of these bonds in the near future, the advantage of placing stockholders in a position to revise the terms of interest on their obligations twenty-five years hence is obvious.

The making of long-term bonds—that is, for the periods longer than fifty years—has many and great disadvantages. The experience of British railroads with their irredeemable debentures and similar obligations selling at enormous prices with no possibility of relief to the stockholder is a warning in this respect. Credit generally is not going to depreciate much in the future, and American railroads seem on the eve of establishing their credit in the eyes of the world.

Ten or fifteen years ago London & North Western directors would have smiled, if anyone had told them that in 1897 their three per cent. obligations would sell at 118. They would have had more reason to smile than would directors in a good American road, if told to-day that ten years from now the credit of their road will be on a three per cent. basis. It does not do to neglect important possibilities for the sake of comparatively unimportant probabilities. The future seems to hold a great improvement in American railroad credit. Prudence dictates such present adjustment that full advantage can be reaped therefrom.

ELECTRIC TRACTION UNDER STEAM-RAILWAY CONDITIONS.

By Charles Henry Davis.

THE determination of the desirability or undesirability of substituting electric traction for steam on parts of some American railway systems is a matter of constantly increasing importance; and on many projected lines the question whether steam or electricity shall be used is a problem that must now be solved, although in the past there was no question as to which should be adopted. We shall probably see during the next ten years a large increase in the substitution of electricity for steam on railways. This change is foreshadowed by the present electrical equipment of elevated railways in Chicago; by the overhead trolley and third-rail experiments of the New York, New Haven & Hartford Railroad Company; by the operation of several branch lines of the Pennsylvania Railroad Company with electric motors; and by the present active discussions, among steam-railway engineers and managers, of the details of first cost, operating expenses, and methods of electric traction. The Illinois Central Railroad Company is again examining into the possible advantages of electric motor cars for its express and local suburban passenger business out of Chicago. They contemplated this change during 1892, but abandoned the idea as undesirable at that time. Their problem, together with the views of prominent electric manufacturing companies, is outlined in an interesting paper by John Findley Wallace, chief engineer of the road, read before the American Society of Civil Engineers (meeting of February 3, 1897).

The Pennsylvania Railroad and the New York, New Haven & Hartford Railroad have terminals, the first in Philadelphia, the second in Boston, where it would be desirable and interesting to study the relative merits of the two systems. Both points offer the greatest possibilities for the use of electricity, because of the large suburban passenger service requiring frequent trains over short distances.

In making a comparison of the use of steam locomotives and electric motors as motive powers, it will be found, in general, that, where the units of transportation are many, light, and frequent, and operated over short distances, the use of electricity will result in lower first cost and operating expenses, and will be more desirable in many ways; while with units that are few, heavy, and infrequent, and operated over long distances, the use of steam locomotives will result in lower

first cost and operating expenses, and prove more desirable. Though this general statement is often modified by special conditions, it will generally govern in determining changes from steam locomotives to electric motors, or the choice of one or the other in the case of newly-projected roads.

The subject can be treated under two heads: (*a*) new roads to be built; (*b*) old steam roads to be partially or entirely changed over. Having determined the factors that control the solution of any problem under (*a*), we can then discuss the additional conditions which should affect our conclusions when considering a problem under (*b*).

In either a new or an old line there is a limiting factor which sometimes precludes the possibility of using electric traction,—the transmission of electric power from the station to the motor. Some problems show at once that, owing to the long distance and infrequent trains of great weight, electric transmission of power would be entirely too costly. Just where the line occurs is hard to define, as it depends upon distance, amount of power, frequency of trains, and their weight. A few years ago it was considered that about ten miles' radius was the limit for one power house; this was before the days of "boosters" and multiphase currents. Without trying to define the exact limit beyond which electricity would be injudicious, we can state that, except for suburban traffic, and interurban traffic between towns a short distance apart, electric traction is to-day too costly both as to original investment and operating expenses. These facts cut out the freight business of steam railways, so that, should electricity be used for suburban passenger business, the local freight business would be handled by steam locomotives, which would also be used in other service. Express and mail business are not treated in this article. As suburban traffic can be considered to lie within twenty miles of the center of population (more often ten miles and never exceeding thirty), electric traction is always worth consideration. The present discussion is confined to these general principles and their limitation of the comparison between the two systems; in a second paper, to appear in the next issue of THE ENGINEERING MAGAZINE, we will consider the comparison in detail.

It is not the purpose in either article to give the actual costs and expenses, or their percentages, except when required to demonstrate a given point, but to show whether a given item will be relatively higher or lower in comparing the systems.

The reduction of first cost to a minimum consistent with work best suited for the purpose is of great importance in the construction of any line. No increase is justifiable, unless it will prove a profitable investment in itself; no decrease, however, is justifiable, if the larger

expenditure promises larger profit; where expenditures can be decreased, without materially lessening immediate traffic or adding to operating expenses, such decrease should be made. The importance of this is seen when we remember that the fixed charges (interest on bonds and rentals) are really a part of the cost of manufacturing transportation,—to borrow an expression from an eminent authority; they are, in fact, one of the largest items in the total cost of running a railway system; they increase in a somewhat faster ratio than the cost of the line, and are the same every year, whether business is good or bad; and we therefore emphasize the importance of reducing the first cost to the lowest amount consistent with true economy, and of increasing the traffic to its maximum, so that the fixed charges may be a smaller percentage of the gross receipts. It must be remembered, however, that the gross receipts are often enormously increased by extraordinary expenditures, in which case large investments may be warranted, such as terminals at or near large centers of population, shortening of line for moral effect and saving of time in competition, adopting new methods as an inducement to increased use, etc. An idea of the weight which should be given to this part of the subject will be had by the following comparison of steam-railway operations:

	Average.	High.	Low.
Per Cent. Operating Expenses	65	70	55
" " Net Receipts	35	45	30
" " Fixed Charges	25	45	14
" " Profit	10	16	4

Examining the above table, which is not supposed to show highest and lowest figures, but averages under ordinary conditions, we see the importance of the item of fixed charges, and the importance, therefore, of reducing first cost. It will be shown in these articles that the first cost of electric roads will almost always exceed the first cost of steam roads,—a decided disadvantage. In a few cases, however, electric roads will involve lower first cost,—namely, where the units are light and very frequent, and where the stops are very frequent; but, in general, the inducement to adopt electricity instead of steam, or to discard the latter, will be the increased travel which undoubtedly comes, in a greater or less degree, to roads using electric motors.

The fact that usually the first cost and the total expenses will be greater with electricity than with steam might lead us to discard the thought of using the former under any circumstances, were it not for the question: How will our gross receipts be affected by the use of one or the other system? Leaving for the second paper the demonstration of the comparative cost of installation and operation under each system, and accepting for the present the general conclusion that the showing on this side is against the electric system, we will pass to the

examination of the other side of the books. If by using electric traction we can sufficiently increase the gross receipts per car-or train-mile and per mile of road, we can afford to pay for the additional first cost and greater total expenses. This is the vital question and the real one at issue, although usually not so considered. Our discussion is limited to passenger receipts. Within the scope of a magazine article we can give only a general idea of the many elements which affect this question.

By examining statistics of steam railways we find that the volume of travel is influenced by such features as the following: convenient location of stations with respect to centers of population; length of line; proximity of terminals to the centers of population; number of trains; (the four points just mentioned have an overwhelming effect on short-haul traffic); good road-bed and track neatly kept; handsome commodious stations, with first-class appointments and service; comfortable and luxurious cars; block signals; cleanliness, etc. Profit is proportional to success in obtaining that travel which enables each train to run full, for the cost of a train-mile is not affected by the number of seats taken; and it is this travel which is obtained by a line giving weight to its "location" and "appointments." In freight competition between railways the rates are ultimately dependent upon the cost from "consignor to consignee," not from station to station, and the railroad eventually pays the additional cost of lighterage, switching, cartage, etc., and the profit thereon, whether by actual difference in rates or loss of business. The same is true in passenger traffic, as will be seen by free omnibuses, reduction in rates, etc. If you can take the passenger up at his own door and set him down at his place of destination, you have not only suited his convenience (and thus, as we shall see, induced him to travel oftener), but have secured those receipts which otherwise would have gone to omnibuses, hackmen, and street-car lines. This the steam railways have failed to do, and it is clear that they cannot altogether do away with these feeders natural to their peculiar modes and conditions of traffic; but there is little room to doubt that in many cases steam railways can modify their present methods, for surburban traffic out of large centers of population and for interurban passenger traffic on branch lines between centers of population, by the use of electricity, paying the additional first cost and greater total expenses out of the probable (we might say certain) enormous increase in their gross receipts. This, I believe, can be accomplished only by a radical change in the present methods of operation, making them approach, on parts of the system, the present "leave-at-your-door" plan of our street railways, while keeping, on the rest of the system, the present methods of

steam railways with possibly some minor modifications. To accomplish this to advantage, the use of electricity will probably prove advisable, although in some instances a combination of electricity with steam might give the best results. Let us consider some of the figures bearing on our problem.

The Pennsylvania Railroad originally spent about $5,000,000 for its Broad street terminal; the great St. Louis bridge and Union Station cost many more millions; while the Market street terminal of the Philadelphia & Reading Railroad, the Union Station of the Boston & Maine Railroad systems, the Southern Union Station of the New York, New Haven & Hartford Railroad in Boston, and the Grand Central Station in New York are proofs of the millions of dollars spent by railway companies to locate their terminals at or near the centers of population. These expenditures were incurred almost entirely for the sake of increasing the suburban passenger traffic, although giving a decided stimulus to through and competitive business. In my opinion, our steam-railway companies can afford to double (to use a broad and inaccurate expression) these investments to accomplish what has been suggested above, reaping a handsome return from the increased gross receipts from the passenger traffic now handled by electric street railways.

Taking the New England States as a basis for comparison,—for there we shall find the shortest hauls, the most dense population, and the greatest number of trains,—we glean from "Poor's Manual" the following figures:

STEAM RAILWAYS IN THE NEW ENGLAND STATES.

(Me., N. H., Vt., Mass., R. I., Conn.)

	1894.	1895.
Length of line operated (miles)	7,452	7,659
Passenger train mileage	31,097,374	30,266,737
Total passengers carried	128,545,855	116,069,178
Passengers carried per train-mile	4.13	3.84
" " one mile	1,842,924,000	1,856,263,668
Passenger earnings—total ($)	34,462,989	34,224,725
" " per passenger per mile (cents)	1.87	1.84
Passenger earnings, average total each passenger per trip (cents)	26.81	29.48
Passenger earnings, per train-mile (cents)	110.82	113.07
Passenger earnings, per mile of road ($)	4,625	4,468
Average number of passengers carried per mile of road	17,250	15,155
Average number of passenger-miles per train-mile	59.26	61.33
Average distance traveled per passenger	14.34	15.99

From statistics of street railways in New England operated exclusively by electricity, including all from which reliable data could be obtained, the writer has compiled the following tables:

ELECTRIC STREET RAILWAYS (1895) IN THE NEW ENGLAND STATES.

(Me., N. H., Vt., Mass., R. I., Conn.)

State.	Total No. of Roads in State.	No. of Roads Taken.	Total Length of Track.	Total Passengers Carried.	Total Passenger Receipts.($)
Maine....	14	9	89.43	8,963,387	478,959
N. H.....	5	3	44.00	3,299,115	161,271
Vt.......	5	—	——	———	———
Mass.....	64	37	612.69	74,241,633	3,692,843
R. I.....	7	4	102.36	30,204,653	1,498,963
Conn.....	23	18	265.02	37,684,559	1,809,646
Totals..	118	71	1113.50	154,393,347	7,641,682

Length of track operated (miles)	1,113.5
Car mileage	———
Total passengers carried	154,393,347
Passengers carried per car-mile	———
" " one mile	———
Passsenger earnings—total ($)	7,641,682
" " per passenger per mile	———
" " average total each passenger per trip (cts.)	4.95
" " per car-mile	———
" " per mile of road ($)	6,862
Average number of passengers carried per mile of track	138,718
" " passenger-miles per car-mile	———
" distance traveled per passenger	———

It is regrettable that there are so many blanks in the above table. The exact car-mileage of electric roads for 1895 not being ascertainable at this writing, this item is necessarily omitted, as well as others depending upon it. But these figures are not essential to the purpose in hand. In comparing the two tables, we must remember that the steam roads include every road in the section, while many electric roads are omitted, and that, in the case of the steam roads, length of "line" is given, while, in the case of the electric roads, length of "track" is given. Therefore the following ratios, steam roads figuring as 1, are only approximate:

Length	1 to .14
Passengers carried	1 " 1.33
Total receipts	1 " .22
Receipts per passenger per trip	1 " .16
Receipts per mile	1 " 1.53
Number of passengers per mile	1 " 9.15

The average number of passengers per car-mile carried by the roads of Massachusetts in 1896 was about 6 (5.95). Statistics of all the

street roads in New England would show the number of passengers carried to be four times as great as the number carried by the steam roads. Assuming the same ratio between passengers and car-miles, there were 25,732,224 car-miles operated by the electric roads, standing to steam-road train-mileage as 1 to .71, or, assuming an average of 4.5 cars per train, as 1 to .15 car-miles. As it is impossible to determine the average length of passenger-trip on a street railway, we can never arrive at the receipts or cost per passenger-mile.

The characteristics brought out by these figures are the enormous number of passengers per mile, the large receipts per mile of road and per car-mile, and the greater total number carried, on electric roads. The steam road gets greater receipts per trip, but carries each passenger a longer distance, and has to run a disheartening number of cars or train-miles for the passengers carried. The difference is due to the short trips, high fare per passenger- and car-mile, and the "leave-at-your-door" service, of electric roads. As our argument is confined, for reasons stated, to surburban and interurban short hauls, we think it plain from what goes before that the adoption of electricity as a mode of operation, with the additional change to the prevailing methods of our present street railways giving nearly the same class of service, (combined or not with steam locomotives as the case may require), will result to the steam roads in an enormous increase of the total passengers carried, passengers per car-mile and rate received per mile, and will shorten the length each passenger is hauled; and, by thus increasing the gross receipts, will more than pay for the additional investment. If this cannot be done in any given case, then it will not pay to make the change.

The conclusion is that electric traction can be profitably used:

(1) Where units are so light and so frequent, and carried so short distances, that steam locomotives cannot be furnished at lower first cost or operated more cheaply, as in the plain case of a street railway;

(2) Where the gross receipts will be so increased by the change of system and the mode of operation as to more than pay for the increased first cost and operating expenses per car-mile, as in the case of suburban steam systems running out of our great cities and interurban systems between large towns situated a few miles apart;

(3) Where competition of parallel electric roads compels the change to save what traffic there is, irrespective of the question whether it will be more profitable;

(4) Where higher speeds are required than can be attained by steam locomotives. (This case has not been discussed in this article; it will be taken up in another paper.)

Should an existing line make the change, the item of loss from discarding old equipment, etc., must be taken into consideration ; otherwise the problem remains the same. In many cases such equipment can be used on other parts of the system. Steam-railway managers should avoid making the mistake which took place in the change from horse traction to electric traction,—namely, of trying to reduce the first cost of changing by the use of old methods, material, and equipment, which, although entirely suited to the old system, proved most unsatisfactory under the new conditions. The old equipment partly made over will not do. There must be new trucks, and new and lighter car bodies, hung lower for greater ease of entrance and departure. Old methods of operation must be discarded, and new ones substituted. A change of system may necessitate additional tracks, which should be provided even at large cost. The nearer the approach to the "leave-at-your-door" service, the greater the success.

Let us consider some examples where it is probable that electricity could be substituted with profit, remembering that more thorough investigation might show, in this or that case, that the change is undesirable.

Suburban service of the Pennsylvania Railroad, out of Philadelphia, as follows:

P., W. & B.	Division	to Wilmington.
Main Line	"	" Paoli.
Germantown & Chestnut Hill	"	" Chestnut Hill.
Reading	"	" Norristown.
U. R. Rs. of N. J.	"	" Tacony.
Westchester	"	" West Chester.

By the use of multiphase current and rotary-transformer sub-stations, one power house, located conveniently on the Schuylkill river, could take care of such a system ; from these sub-stations direct current at 500 volts would be fed into the trolley or third-rail line. The equipment should be entirely new ; cars of the same seating capacity, but lower and of lighter construction, should be used ; the bridge over the Schuylkill river into Broad Street Station should be widened by four additional tracks ; main line and U. R. Rs. of N. J., by two tracks, each ; P. W. & B. should have a total of four tracks ; Germantown & Chestnut Hill, Reading, and West Chester should each have a total of three tracks ; all tracks should be equipped electrically, although some of them would be used by steam locomotives hauling freight and through passenger trains, and some or all, at times, by both systems. Two tracks should be laid in the street from Broad Street Station to the Schuylkill bridge coming to railroad grade at that point ; the cars running over these tracks should operate from the

Delaware river out Market street, by trackage arrangement with the street railway or by special franchise, the street being wide enough for four tracks; they should be run as any street-railway line is run to-day, and continue out on the extra tracks, provided above, as far as circumstances might warrant, and should be extended as travel required; right of way should be prepared, so that passengers could leave or enter these cars at any point along the line. Local stations should be provided, in some cases much closer than at present, at which passengers, on the cars mentioned above, could change to electric cars stopping only at said stations, or to express electric trains stopping at fewer points, all being done by the payment of a single fare. It will be seen that this is a combination of the street railway on the outside tracks with the local and express service of a steam road on the inside tracks, while the through locomotive trains operate on the middle tracks. The proposition is a radical one, is advanced as such, and will bear close investigation and study; the expense would be enormous, but the gross receipts from such a system of street railways, accumulating passengers for the rapid-transit system connected so intimately with it, would also be enormous,—in fact, I believe, far in excess of anything yet accomplished in transportation of passengers.

The same treatment of the following terminals, with modifications to suit each case, would be worth studying:

New York, New Haven & Hartford Railroad, out of Boston;
Boston & Maine, out of Boston;
Philadelphia & Reading, out of Philadelphia;
Harlem, New York Central & Hudson River, and New York, New Haven & Hartford Railroad Companies, out of New York city;
Central Railroad Company of New Jersey, out of Jersey City;
Illinois Central Railroad, out of Chicago.

It must not be inferred that in any of these cases investigation would prove the expense warranted,—especially that of laying additional tracks. It is, however, my judgment that in most cases additional tracks would be necessary to make the system profitable. Many examples might be given of interurban steam railway systems where investigation might show that it would be profitable to change to electric traction. In concluding the general discussion, and before taking up the detailed examination to follow next month, emphasis must be placed upon the importance of radical changes in present steam-railway methods to make the change to electricity pay. Electric traction in connection with existing tracks and equipment and under existing operative methods will result in heavy loss and ultimate abandonment of the change—possibly even in disaster.

CANAL IRRIGATION IN MODERN MEXICO.

By C. P. MacKie.

THE attention now being paid to scientific irrigation is only another case of history repeating itself. In fact, in the United States and Mexico, irrigation was practised extensively long before the beginning of authentic history. At the time of the Spanish invasion of Mexico, the Indians in those parts of that country where the population was greatest were dependent upon this method of agriculture for a large part of the cereals and cotton which played so important a part in their economy. As the same method had been employed from time immemorial in old Spain, it followed that, on the partition of the soil among the Spanish conquerors, irrigation became almost the basis of their agriculture, and has continued so to be, on a constantly-expanding scale, for the three hundred and fifty years that have elapsed since their final occupation of the Mexican territory.

With the extension of railway lines and the notable impulse given to agricultural enterprise within the last twenty years, Mexican land-owners have improved more and more upon the earlier methods, and have, to an increasing extent, applied the principles of engineering science to the methodical cultivation of the large tracts into which their holdings are usually divided. While these increased facilities are opening up new and extensive regions among the fertile lands of the coasts, the great land-owners of the plateau, where tillage was conducted on antiquated lines, are responding to the same impulse of progress by more scientific employment of their peculiar advantages. The present article describes a typical modern enterprise of this nature,—the largest as yet undertaken in the republic, but probably only the first of a series of similar undertakings to be established there.

The great plain of northern Mexico embraces nearly the whole of the States of Chihuahua and Coahuila, being bounded east and west by the Sierras of the Pacific and Gulf coasts respectively. It consists of two water-sheds,—that of the Rio Grande to the north, and the so-called Desert of the Bolson de Mapimi in the south. It is about 400 miles wide by 600 long, and maintains a general level of about 4,000 feet above the sea, although much broken by local mountain ranges. The Bolson de Mapimi has much the same formation as the basin of the Great Salt Lake. It receives the drainage of all the eastern slopes of the Durango Sierras and the western slopes of the Coahuila ranges, but possesses no outlet. As a consequence, throughout its whole area, the rivers run into broad, shallow lakes, whence the waters are gradu-

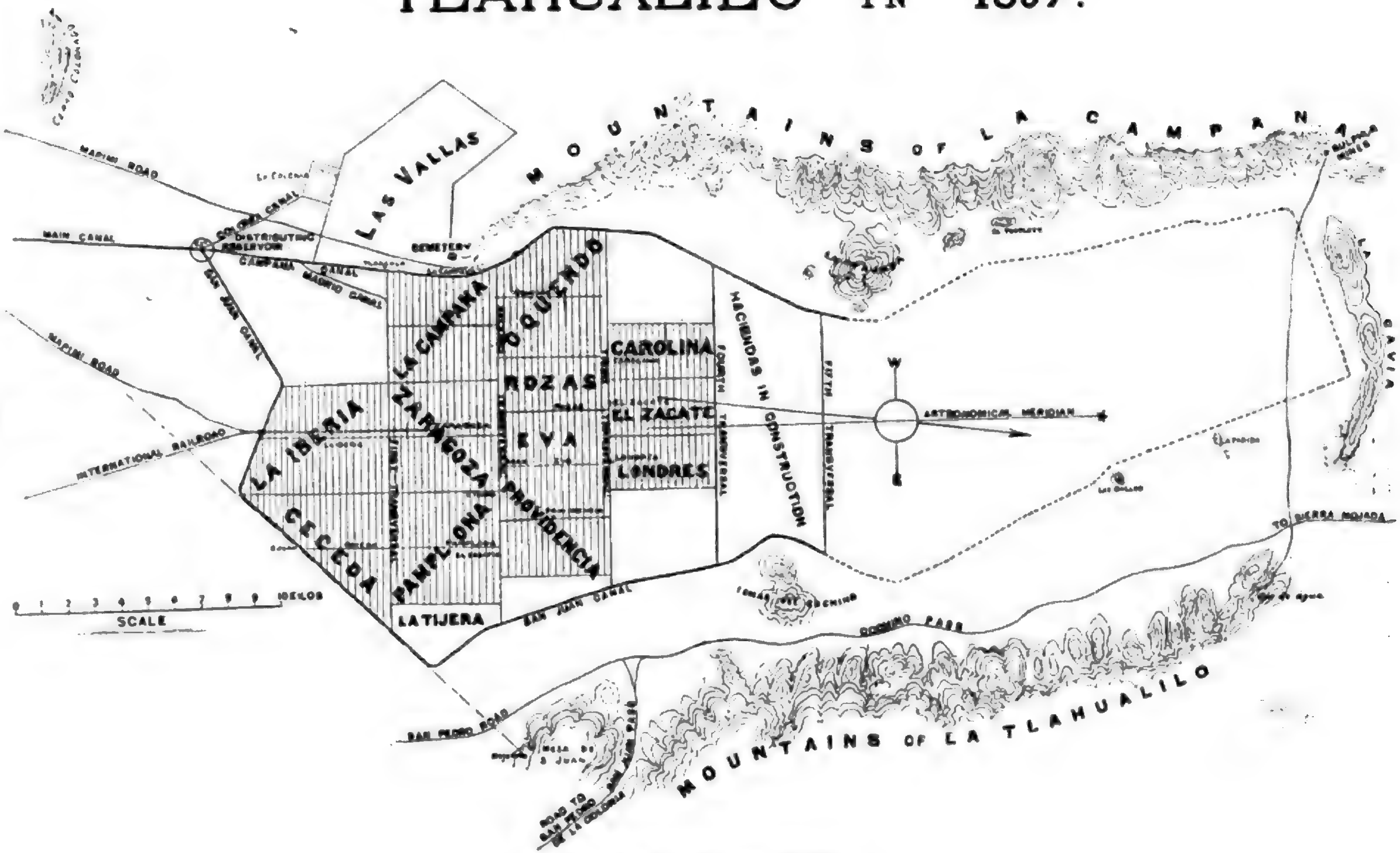
ally lost by evaporation during the dry season. Of these rivers, the largest is the Nazas, which has a course of nearly three hundred miles from its source to where it is dispersed over the shallows, called on modern maps Lake Mayran. Sixty or seventy years ago the Nazas discharged its waters into a series of extensive lagoons, occupying what is now the fertile Laguna district of Durango and Coahuila, still often depicted on the maps as Lake Cayman. About that time a phenomenal and long-continued rain-fall so overcharged the then bed of the Nazas as to cause it to open a new course and leave the Cayman lagoons thirty miles on one side. In the course of years these lagoons were converted into a mesquite wilderness, almost dead level and composed of a deposit of the finest detritus, of unknown depth. The central depression of this lake-bed filled a broad valley running north and south and surrounded by a parallelogram of mountains. The area thus comprised was about two hundred and ten square miles of pure vegetable loam, locally known as the Lake of Tlahualilo. This *cuenca*, or bowl, was the spot chosen about six years ago for the establishment of the great irrigation enterprise now under review.

The problems involved called for courage and high administrative qualities, as well as technical engineering knowledge. It had early developed that the lands left dry by the changed course of the river were of extraordinary fertility, and a half a century ago those tracts immediately adjacent to the river had been taken up and brought under irrigation after the rough methods then practised. The result was that by 1890 about 250,000 acres of this land were under ditch, and the region was producing the greater part of the cotton grown in Mexico, as well as heavy crops of corn and wheat. The Tlahualilo basin was known to be the richest portion of this district, but the thirty miles of sun-baked desert separating it from the present course of the river presented an obstacle to its utilization which proved too formidable for the then cultivators of the Laguna country. In 1889 a project was formulated for carrying a ditch across the intervening desert to the head of the Tlahualilo *cuenca*, and converting the whole of the latter area into a huge hacienda. Don Juan Llamedo, a prominent Spanish capitalist and landed proprietor of Mexico City, was invited to realize this plan, and the unfailing public spirit and far-sighted patriotism of President Diaz aided the enterprise by the concession of the water privileges and rights of domain necessary for its success. Preliminary survey showed that the lowest level of the basin to be irrigated was about one hundred feet below the point on the River Nazas which it was proposed to dam; that the main canal, on account of topographical conditions, would require a development of 39 miles; and that the slope of the lands within the basin was such

DON JOSE FARJAS.

that about 175 square miles out of the 210 composing the basin could be advantageously irrigated. A company was formed to undertake the work, and the organization and execution of the plan of irrigation was entrusted by Señor Llamedo to Don Jose Farjas, an officer of engineers in the Spanish army. An estate of more than 20,000 acres, lying on the River Nazas above all existing dams, and controlling the water-supply, was purchased, and a dam of piles and rip-rap thrown across the river at a point where it is about 1,500 feet wide at flood. From this dam the line of the main canal was traced to the entrance of the Tlahualilo basin,—a distance, as has been said, of 39 miles. The canal was given a width of 72 feet at the base, a depth of 6½ feet, and a grade of from 18 inches to 3 feet to the mile, except as to one section to be later referred to. It terminated in a distributing tank, at the entrance to the irrigable area, whence it bifurcated, one arm being carried along the western side of the basin and the other along its eastern side. These branches preserved the same average grade; one of them being 15 miles long with a width of 30 feet at the bottom and a depth of 5 feet, and the other being 13 miles long with a width of 36 feet at the bottom and a depth of 6 feet. The area thus enclosed as a beginning was approximately 90 square miles, or about 57,000 acres, and the lines of the side canals were prolonged down each side of the basin until they met at its farther extremity, thus encircling all of the available land. For the time being, however, construction was limited to the distance above referred to. The 90 square miles which were to be first irrigated were laid out in blocks of uniform size, each one containing a Mexican *sitio*,—a conventional area measuring a Spanish league on either side, and embracing about 4,338 English acres. This was accomplished by digging transverse ditches at right angles to the side branches, and running

TLAHUALILO IN 1897.



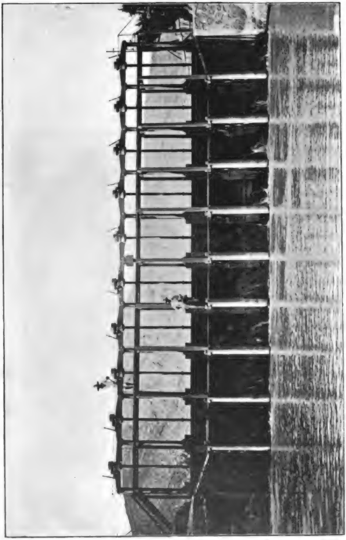
SKETCH MAP OF THE CANAL SYSTEM.

from one to the other. The first of these transverse ditches was a Spanish league (2½ miles) from the distributing tank; the second, the same distance farther on; and so on. Each of them was 25 feet wide at the base and 3½ feet deep. These transverse ditches were, in turn, connected at distances of half a Spanish league by similar ditches at right angles to the "transversals," but parallel with the side branches, having uniform dimensions of 13 feet in width at the bottom and 3 feet in depth. Finally, these parallels were connected, also at right angles, by distributing ditches at intervals of a little more than 800 feet, with dimensions of 6½ feet in width at bottom and 2½ feet in depth. From this description and the accompanying map it will be seen that the system adopted secured absolute uniformity of dimension, both as to ditches and areas of land, thus securing also the incalculable advantage of simplicity and symmetry in the irrigation of the lands and in their subsequent agricultural administration. The unit of cultivation was the *tablas* between the distributing ditches, each of which was 285 yards wide by 2,280 yards long, or about 134 acres. Sixteen of these lay between each pair of parallels and the respective transverse ditches, and two of such blocks, or the area embraced between every second parallel and its corresponding transversals, constituted the *sitio* of 4,338 acres, which was made the unit of administration. The total ditching called for under the above plan was as follows:

Main canal..............	72-97 feet wide,	6½ feet deep,	39 miles
First branch canal........	33-35 " " ,	5 " " ,	15 "
Second " "	36-42 " " ,	6 " " ,	13 "
Transverse canals.........	21-23 " " ,	3½ " " ,	29 "
Parallel ditches............	13-16 " " ,	3 " " ,	50 "
Distributing ditches.......	6½-9 " " ,	2½ " " ,	400 "

The total excavation called for was about 3,700,000 cubic yards for the main canal, and for all the other canals and ditches on this first section about 3,400,000 cubic yards.

The construction of the works was unusually laborious, on account of the difficulty of obtaining water and supplies for men and animals after reaching the limit of convenient haulage from the river. For twenty-five miles of the distance all the water required for the laborers as well as the animals had to be carted, as well as all of the supplies. From 2,000 to 3,000 laborers, Indian peons, were employed on the work, and the time consumed in digging the main canal was a little more than a year. Most of the excavation was done in the peculiar indurated clay, approaching almost the density of soft stone, called by the Mexicans *tepetate*, which, while hard to work with pick and spade, affords a very consistent and permanent bank. Some trouble was ex-



HEAD-GATES OF THE MAIN CANAL.

THE MAIN CANAL AT LOW WATER.

perienced from ridges of rock which had to be blasted, and again from beds of drifting sand which had to be secured, but by far the greater part of the work was through *tepetate* and sandy loam. Within the first few miles the line of the main canal traversed three large irrigating ditches, furnishing water for haciendas farther down the river, and these had to be deviated from their former course and carried over the Tlahualilo canal on iron aqueducts. About twenty-five miles from the river the ground dropped off rapidly in the direction the canal was taking, and for three miles it was necessary to increase the grade to eight feet to the mile,—a proceeding which would have been of doubtful prudence but for the durable banks and bottom afforded by the peculiar formation alluded to. About half way down its length the canal cut the line of the Mexican Central Railroad, and here it was necessary to introduce a permanent bridge and take due precautions against washings and over-flow.

The intake of the canal on the river was substantially built of cut masonry laid in Portland cement, with massive wing walls. The gates are ten in number, each 6 feet wide, and, with their frame-work, are of iron. The bottom of the canal for some distance within and without the gates is laid in cement and stone. The sill of the intake is 6 feet below the level of the river dam. The distributing tank at the end of the thirty-ninth mile is built in an equally substantial manner. When this point was reached, work was pushed along the two side branches, and, as fast as they were completed, the transverse canals, parallels, and distributing ditches were opened up between them. As this work progressed, part of the laborers were withdrawn from ditching, and employed in clearing the lands of mesquite and cactus. An ample equipment of the most approved agricultural implements and utensils had been imported in advance from the United States and England, and there was thus no dislocation of energy, some of the peons being shifted from ditching to clearing the land, and then to its ploughing and cultivation, while others were assigned to the work of constructing the many edifices required for the large agricultural operations contemplated.

This preparatory work was so planned as to develop into the permanent administration and operation of the properties without further complications. Each of the *sitios* of 4,338 acres was placed under an administrator, who had his own cashier, accountant, and necessary foremen, with his quota of labor and equipment. He was charged with the work of constructing at a central point on his hacienda a village, containing the administration buildings, magazines, storehouses, stables, corrals, houses for his laborers, and a reservoir of water. The general administration was located on the hacienda of Zaragoza, about

THE MAIN CANAL AT HIGH WATER.

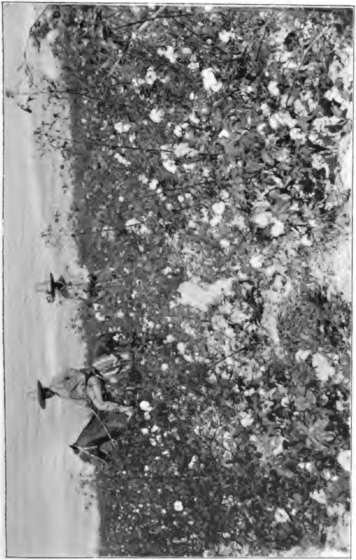
EXTENDING THE DITCHES.

eight miles down the basin from the distributing tank and nearly in the center of the land then being prepared for cultivation. At this point, in addition to the hacienda buildings above enumerated, extensive manufacturing facilities were erected, consisting of a steam cotton gin, an oil mill for handling all the cottonseed oil, a soap factory for utilizing the oil product, a cotton press, and an electric-light plant. There were also built a church, a public school for the children of the company's employees, a general market, a hospital, and other conveniences for the welfare of the population in their isolated position. Throughout the whole property, the main buildings were substantially constructed of adobes and brick, with tiled roofs. A system of wagon roads following the lines of the main canals was laid out to connect all of the villages with the central administration, and telephone communication was established between all of the administrators and the general manager at Zarogoza. During the present season nearly thirty miles of narrow-gage railway, operated by steam, are being laid down to facilitate transportation from the more distant parts of the estate to its industrial center. The track is laid on the dikes of the large canals, as far as possible, thus avoiding the lands overflowed at the time of irrigating. Cotton-wood and eucalyptus trees have also been planted along the larger ditches, for the double purpose of affording shade and breaking the winds on the broad plains.

The method of administration adopted on the completion of the ditches accords with this general plan. The admission and shutting off of the water, the distribution and rotation of the crops, and similar matters of general policy are determined by the general manager at headquarters. The local administrators are expected to keep up the property under their care, oversee the intelligent cultivation of their fields, maintain their ditches, roads, and bridges, and generally care for all the details of the haciendas under their charge. Each administrator is responsible for the accounts of his own hacienda, including the cost of cultivation and the products derived therefrom. He renders a daily statement to the general manager, and receives each day the amount of cash necessary to meet his daily pay-roll, such daily payment in hard cash having been found a sovereign cure for such labor troubles as the peon thus far knows. The company maintains no shops of its own, and allows no monopolies; it grants licenses to any shop-keepers desiring to establish themselves on its property, and applies the sum thus derived towards the maintenance of its public schools. Military discipline is maintained in all of its villages, and prohibitive penalties make the sale and use of intoxicating liquors a costly luxury both for seller and buyer.

The rainfall in the Bolson de Mapimi is confined to a few days of

COTTON FIELDS AFTER THE SPRING IRRIGATION.



COTTON FIELDS AFTER THE FALL IRRIGATION.

heavy showers about the beginning of June and the beginning of December. But up in the mountains of Durango, where the Nazas takes its rise, the rainfall at the same season is very heavy and protracted, resulting in high water in the river, which lasts for several weeks at a time. It is during these freshets that the cultivated lands in the Nazas district are irrigated. For the rest of the year they receive no water, except from occasional brief showers. In the Tlahualilo basin, a week or ten days of irrigation is all that is needed in the course of a year, the water soaking easily and quickly through the almost impalpable silt, and the hot sun forming a protecting crust which checks evaporation and retains the moisture in the sub-soil for a surprisingly long time. In fact, owing to their long roots, the cotton plants strictly require irrigation only once every other year, but corn and wheat, of course, must receive it at each planting.

A PRODUCT OF IRRIGATION.

The distribution of the waters is regulated by government schedule, each property on the river being allotted its proportion of water, according to priority of settlement. Each canal on the river is permitted to take as many irrigations as it desires during the season of high waters, but in strict rotation. That is, after a property has taken one quota, it cannot repeat the process until all the others have taken theirs, when its second quota is available. Where another property, as often happens, does not care to use all the water to which it is entitled, its further allotments may be used by its neighbors.

For the Tlahualilo canal the maximum delivery at the distributing

A FARM SUPERINTENDENT AND HIS STAFF.

MEXICAN INDIAN LABORERS AND AMERICAN MACHINERY.

tank at the entrance of the basin would be 1,440 cubic feet per second, with an irrigating capacity of about 115,000 acres of land, calculating the duty to be 80 acres per cubic foot. This is allowing a reduction from the amount entering the head-gates at the dam of about twenty per cent. for evaporation, seepage, and absorption, which is found to be a fair allowance in the region traversed by the canal. Actually, for the amount of land at present under ditch on the haciendas,—say, 57,000 acres,—the water service is about 650 cubic feet per second. About eighteen hours elapse from the time the water enters the head-gates before the ditches begin to fill on the haciendas. The water is served to each of the *sitios* in order, the ditches of each *sitio* being shut off by their respective sluice-gates when full. For the purpose of thorough irrigation, the *tablas* of 134 acres each are divided by low internal banks into convenient squares, and the water is admitted into each of these squares from the distributing ditches, until it stands about two inches deep over the entire area. It is then shut off, until the time for another irrigation. By this process every plant, from the first ditches on the haciendas to the last, receives its modicum of water, without danger of excess. The waters, on leaving the river, are heavily charged with sediment largely volcanic in its origin, and this is deposited on the lands at each flooding, in the shape of extremely fine mud.

Owing to the distance from the nearest coal mines, the question of fuel is an important one, as there are at present more than three-hundred h. p. in constant use, and the amount is steadily increasing. The main supply is from the mesquite brush, which is cleared from the new lands as the work of ditching and preparation advances. The hulls of the cotton seed also make a hot, but quick, fuel for some of the larger stationary engines. The wheat straw and cotton bushes are utilized for brick burning and for the domestic purposes of the laboring population. The engines and fixed machinery, as well as all the agricultural machines, are operated by native labor, the peons having been found quick and efficient in acquiring a certain degree of mechanical knowledge. During the period of greatest activity, when the cotton crop is coming in, the gins, presses, and oil mills are kept running day and night, the company maintaining a considerable electric-light plant for this purpose. All the products of the haciendas are shipped direct from the station at Zaragoza to their destinations. The cotton, wheat, corn, and soap are all marketed in the republic; the oil cake is shipped to the United States. Most of the machinery and implements employed are of American origin, and their aggregate is very large, there being at present more than seven thousand American plows of different types in use on the estates.

The recent construction of a branch line from the Mexican International Railroad at Matamoros across the plains to the center of the Tlahualilo property, by supplying adequate transportation, has made it possible to extend cultivation to the remainder of the basin. The side canals are being prolonged, and, pursuing the system heretofore adopted, four new *sitios* of 4,338 acres each are being prepared for their first irrigation later in the year, and for equipment with the standard type of villages and all necessary appliances. It is purposed to continue this work as rapidly as the work of ditching and clearing will permit, and it is estimated that by the end of 1899 the entire area of 175 square miles will be under ditch and producing.

Six years of experience with this property demonstrates the fact that irrigation, when applied to fertile land under a carefully-planned and thoroughly-executed system, where the water-supply is owned by the user, puts agriculture among the least dubious of industries The plan adopted by the Tlahualilo Company is especially worthy of attention, because of the notable unity of plan pursued from the inception of the enterprise to its fullest development, and of its resultant economies. Too often enterprises formed for the furnishing of water for irrigation purposes fail for want of a market for their water; and others, formed for the utilization of such waters, fail because of excessive cost, or of friction with the controllers of the water supply. The remedy would seem to be an enlargement of the scope of such enterprises, so as to include both the control of the water-supply and its utilization. Under thorough systematization, proper control and direction can be exercised economically and efficiently, from the admission of the water at the first head-gates to the shipment of the marketable products to their final destinations. Methodical control is the basis of successful operation in railroad and other industrial enterprises on a large scale, and the example we have given proves that like causes will produce like effects in agricultural operations as well.

AMERICAN AND BRITISH BLAST-FURNACE PRACTICE.

By J. Stephen Jeans.

COMPARATIVE LABOR COSTS IN THE UNITED STATES AND EUROPE.

WHENEVER pig-iron makers have assembled for the purpose of comparing experiences as to the cost of iron-production in different districts or countries, it has been the custom to appeal to the average volume of output as the standard of efficiency. In only a few examples that I know of has the output of pig iron relatively to the number of hands employed been appealed to. There is, no doubt, good reason for this reticence as to labor costs. Those whose labor costs are high are hardly likely to disclose a fact that would probably be quoted against them, perhaps to their discredit. Those, on the other hand, whose labor costs are low are just as little likely to make disclosures leading to inquiries and to action calculated to deprive them of comparative advantages, due to a low district rate of wages, or to an exceptionally efficient system of administration.

In determining the comparative efficiency of blast-furnace working from the labor point of view, there are three standards that we may appeal to. The first of these, dealt with in a previous article, is the actual output of the furnace; the second is the output relatively to the number of hands employed; and the third is the output as measured in terms of labor costs per ton of pig.

It is obvious that the first of these determinants is not necessarily an effective measure of comparative economy. The fact that a blast furnace may be producing four hundred or five hundred tons of pig every twenty-four hours does not alone establish a criterion of efficient working, because that output may be obtained at so high a labor cost as to make it relatively more expensive than a smaller output produced under different conditions. There is, to be sure, a presumption that a large output means economy of labor, but not a certainty.

It is interesting, and to a certain extent profitable, to ascertain, as far as possible, how the different iron-producing countries compare with each other from the point of view of labor-efficiency at blast furnaces. But we can hardly take up any economic subject in reference to which there is a greater liability to error. Time and again it has been my duty to point out that a comparison of the output of minerals in different districts or in different countries is valueless as a test of labor-efficiency, unless all the differentiating conditions are understood and taken into consideration,—regularity of working, depth, thick-

ness, and character of seams, and many other elements affecting the ultimate cost. It is much the same in reference to the pig-iron industry. The size and character of the furnace, the physical structure of the ores and fuel, the comparative poverty or richness of the mineral, the grade of iron made, the pressure and temperature of the blast, and other manifest influences have all to be taken into account in the estimation of the comparative efficiency of different works or districts.

There are two methods of approaching this subject: first, that of dealing with different countries, as such; second, that of considering the circumstances of individual works. We cannot, except to a very limited extent, adopt the latter system, partly because the owners of individual works are likely to entertain a natural reluctance to seeing themselves used for such a purpose, no matter whether their results are better or worse than the average, and partly because the results of individual works cannot, as a rule, be accepted as typical of a whole district or country. The greater includes the less; and, if we deal with each country as such, we shall both give a greater breadth to our subject, and avoid the liability to errors of generalization that would be incurred under any less comprehensive method of treatment.

On the threshold of our inquiry we are met by a formidable and insuperable difficulty. All countries now collect and publish statistics of the production of pig iron, but all countries do not collect and publish statistics of the numbers employed in particular industries; and, in the absence of data on both points, we cannot make a just comparison. Fortunately, we have complete labor statistics for Germany, Belgium, Sweden, Austria, Luxembourg, and Russia; but we have no similar returns for the United States, Great Britain, or France. Up to a certain point, therefore, we must confine our comparison to the published official returns of the six countries first named. The census returns for the United States are doubtful, and the available returns of individual districts or works in the United Kingdom scarcely go far enough to enable any general estimation of results to be arrived at that would be effective for purposes of international comparison.

I.—Belgium.—In this active little country the records of the manufacture of pig iron have been officially collected and published for upwards of half a century, so that we are able to go back to an earlier date here than in any other country. In 1845 the total output of pig iron in Belgium by 2,331 workmen was 134,563 tons, or an annual average of only 58 tons per workman. In 1850 this average had not improved, but in 1855, mainly owing to the substitution of coke for charcoal furnaces, it had risen to 66 tons, and in 1860 to 80 tons, while in 1865 the average had attained 97 tons, or nearly twice the figure recorded for 1845. Even so, however, the Belgian pig-iron in-

dustry was only on the threshold of its advances, from the labor point of view. Old plants were got rid of, and new plants were substituted rapidly, during the next twenty years or so; hence, in 1884, the average output per worker rose to 207 tons, or more than twice the average of 1865. At this date Belgium was ahead of every other iron-making country in point of economical production of pig iron at the furnace, although not necessarily producing iron more cheaply than any other country. The nearest approach to the Belgian standard between 1883 and 1885 was that made by Luxembourg, which produced 194 to 200 tons per worker, and Luxembourg was followed at some distance by Germany, with an average of 145 to 150 tons per worker. As for the United States, we can say only that in 1880 the total number of hands employed at the blast furnaces, according to the census returns, was 41,875, which, divided into the output of pig iron in that year, gives an average annual output of only 80 tons per worker, or 61 per cent. less than the Belgian average. American iron works at that time had their records still to make; but, if late in starting, they have certainly gone ahead since, especially during the last ten years.

This early advance made by Belgium in blast-furnace practice has perhaps hardly been recognized as it deserves to be. It was no doubt affected to a certain extent by the fact that the indigenous minerals of the country had become scarce and dear, and iron smelters were forced to seek for supplies elsewhere. Between 1870 and 1875 Belgium imported larger quantities of iron ore than any other iron-making country in Europe, and, although these imports included a considerable quantity of the lean minette ores of Luxembourg, they also embraced so large a proportion of the richer ores of Spain and other countries as to facilitate a larger output per furnace and per worker. In the interval since 1885, the blast-furnace practice of Belgium has further improved, although not to the same extent as in the previous twenty years. The average annual output of pig iron per worker over the last two or three years has varied from 270 to 280 tons, which compares favorably with that of other European countries, except the United Kingdom, where, as we shall see later, the average rises to a considerably higher figure.

II.—GERMANY.—It is less than a quarter of a century since Germany was the most backward metallurgical country in Europe, from an iron- and steel-making point of view, and in the interval the relative progress made by German smelters has been only slightly behind that achieved by the United States. In 1872 the average annual output per workman employed at the blast furnaces of Germany was only 76 tons less than one-fourth of the estimated average of Great Britain at the present day. But from this low point steady progress was made,

year by year, until in 1880 the average rose to 129 tons, and in 1890 to 186 tons. Since 1890, short as the interval has been, considerable further progress has been made, the average having been 205 tons in 1893, and 220 tons in 1895. Germany still appears to be a good deal behind either Belgium or Great Britain from the point of view of labor efficiency. This, no doubt, is mainly a function of the generally lower grade of the ores used in German blast furnaces. Of the total output of pig in the German empire, amounting now to over six million tons a year, not more than about half-a-million tons are made from ores that average more than 42 per cent. in the blast furnace, whereas in Great Britain about 3,500,000 tons of pig are now made from ores that will average 52 per cent. to 54 per cent., which obviously aids Great Britain in such a comparison. There are, besides, many parts of Germany where the blast furnaces are still behindhand, although there are other cases, as we shall shortly see, where they are well to the front.

Nearly two years ago, as the secretary to the British Iron Trade association, I was called upon to take a prominent part in organizing a delegation of employers and workmen for the purpose of inquiring into the economic conditions of the iron industry of continental Europe. As secretary also of that delegation, it was my business to pay visits to a number of the leading works in both Belgium and Germany for the purpose of ascertaining the differences between British and continental methods of working. Some of the workmen who composed that delegation attached much importance to the differences in the numbers of hands employed at furnaces, rolling mills, or steel works at the several establishments visited, and insisted that the numbers at work relatively to a given output were much greater than at similar works in England. In some cases, no doubt, this may be the fact; but at one of the works in Germany, which may be looked upon as typical of several large establishments in Westphalia, we found that twenty-seven men were employed per shift at each furnace making basic iron; and, as the average output of the furnaces was about 750 tons per week, it follows that the average annual product per workman was 720 tons, which is a very different showing from the average recorded for the empire as a whole. In this case, of course, we counted only the men employed at and about the furnaces. It may be interesting to show how these figures were made up, as furnace-owners may thereby be enabled to make a comparison with the similar data available for American and British works.

The *personnel* per furnace per shift was thus composed: three smelters; one tapper; two chargers; four coke, etc., fillers; four ore fillers; four transport men; one lift man; one weigh man; three men

at switches, etc. ; one stoneman ; one limestone breaker ; one ore breaker ; one locomotive man. Probably it may be argued that this does not include the sum of furnace labor ; it may be argued that the men who are at the blast engines, at the boilers (engaged in repairs), and at the pig beds, and even clerical labor should be included ; but at any rate the enumeration gives a basis from which to work in comparing the similar records of other localities.

III.—SWEDEN, ETC.—The conditions under which the iron industry of Sweden is carried on possess little more than a merely academic interest, so far as labor is concerned, for the iron-making world generally. All the pig produced is charcoal ; the furnaces are small and worked irregularly ; the ore, as a rule, is exceptionally rich ; the motive power is largely furnished by water ; and the hands do not work exclusively at the furnaces, but alternate metallurgical with agricultural pursuits. In some of these matters, changes have occurred within recent years which tend to place the Swedish iron industry on a somewhat different level from that which it formerly occupied. Thus, for example, if we go back to 1866, we find that the average number of working days per furnace per annum was only 150 ; in 1876 it had risen to 190 ; and in 1895 it was 252. The average annual production of pig per man employed was only 64 tons in 1866, which advanced to 77½ tons in 1876, and has in late years increased to more than 100 tons, the average annual output per furnace having concurrently increased from 1,045 to 3,170 tons. Sweden, indeed, can hardly be looked upon as having to meet competition in the sense in which other European countries have to face it. Her remarkably pure ores, her unlimited supplies of charcoal, and the characteristics of her industry generally, mark it as a thing apart. The same observations apply, *mutatis mutandis*, to the still less important, but yet more isolated, iron industry of Finland, where the average annual output of per man working at the furnaces is only from 65 to 75 tons, the total annual output being less than that of one of the smallest furnaces in the United States. Nor does it appear to be expedient to make extended reference to either Austrian or Russian blast-furnace practice,as the isolation and special conditions in both countries rule them out of any international comparison founded on modern competitive conditions.

IV.—THE UNITED STATES.—In no country has economy of labor within late years been carried farther or become more effective in relation to the pig-iron industry than in the United States. The question has often been debated between British and American pig-iron makers whether labor is more economical in the one country than in the other,—that is, as measured in terms of annual product per employee. The blast-furnace practice of Great Britain, until lately at any rate,

claimed to be ahead of that of any other country from this point of view, and Sir Lowthian Bell and others have denied that American practice was more satisfactory than that of Great Britain, owing to the larger number of hands that were generally understood to be employed. In this respect, however, considerable changes have again taken place during recent years, as we shall see later.

That the cost of labor employed at the furnace in the production of a ton of pig-iron was formerly excessive in the United States can hardly be questioned. The former secretary to the Eastern Ironmasters' Association has put on record the labor costs at the furnace for a series of years preceding 1880, showing that in some years it was as much as $5, and that between 1864 and 1877 it was never less than $2.50. Sir Lowthian Bell has given details of furnace practice which he obtained at works visited between 1871 and 1875, showing that the labor cost per ton of pig at the furnace, during that period, was between $2.50 and $2.75. At the blast furnaces in the south the average wages per ton in 1880 exceeded $6. These high figures are now a thing of the past. In the best American furnace practice of to-day, the average labor cost at the furnace per ton of pig does not exceed a dollar, and in some cases is materially less. So far as my information goes, the labor cost at the new furnaces at Duquesne will not much exceed half-a-dollar per ton of output, and in the south in 1890 the average wages paid at the furnaces was only $1.05 per ton.

In 1895 I paid a visit to the United States and made inquiries into the conditions of labor at some of the principal blast-furnace plants, a portion of the results of which have been published in the *Iron and Coal Trades Review*. One of the points upon which I sought information was that which has been discussed in this paper. I learned that at some of the best plants the number of hands employed to produce 250 tons of pig iron per day was 126, so that the daily unit of product was about two tons of pig per man, including all artisan labor. This is a high average. It may be taken to represent the best American practice on anything approaching a large scale. But it is not equal to the average of some British works within my knowledge, where the average annual product per employee exceeds 800 tons, using bessemer ores in both cases. In districts where leaner ores are employed the output is naturally less. I have before me particulars of one of the largest and best-equipped plants in the Midlands, using clay ores, averaging not more than 40 per cent. of iron, where the average daily output per employee is 1.6 tons of pig, or nearly 600 tons per annum. I greatly doubt whether better results are obtained at any American or European (continental) works using similarly low-grade ores.

All American and most continental ironmakers are acquainted with

the very elaborate details which were collected and published on this subject by Mr. Carroll D. Wright as the United States commissioner for labor, in 1890. I have examined Mr. Wright's figures, perhaps as carefully as any one, and I have come to the conclusion that, although for most practical purposes they are of comparatively little value,—chiefly because of the absence of information as to geographical and other governing conditions, without which no fair comparison is possible—yet, in one respect they are not far from the truth, *viz.*, as to the average cost of labor at furnaces making bessemer iron at that time.

Like other investigators in the same economic field, Mr. Wright has found the extreme difficulty that always exists in procuring figures relevant and parallel to each other, but, if we take his figures for the United States, Great Britain, and an iron-making country on the continent,—presumably Westphalia,—and assign to the latter the same items for clerical labor and taxes as have been ascertained for British furnaces, we have the following result:

	Cost per ton of pig iron.		
	United States.	*Great Britain.*	*Continent of Europe.*
Labor	$1.386	$0.669	$0.517
Officials and clerks	0.158	0.056	0.056
Supplies and repairs	0.533	0.406	0.406
Taxes	0.039	0.020	0.020

I feel sure that the British figures are fairly typical, but the continental figures represent an exceptionally favorable condition of affairs, and it is probable that of the total costs at the furnace in this latter case, amounting to $0.999, something more should be assigned to labor, and something less to the other three items; but, even so, the margin of possible error can be only slight. The figures ascertained by the commissioner of labor show that in the United States, in 1890, the labor cost at the furnace of a ton of pig iron was twice what it was in Europe. Now, this difference is so serious that it suggests either a very much higher rate of wages in the United States, or a lower labor efficiency. Compared with continental Europe, I have no doubt that the difference against American labor costs is wholly due to the higher rate of wages paid, seeing that the official average recorded for Belgian blast-furnace labor is not much more than two shillings per day. But this remark is by no means equally applicable to British labor. Indeed, I am in a position to assert with confidence that at the present time, and for at least two years past, the difference in the rate of wages paid at blast furnaces in Great Britain and the United States is not so much as is commonly supposed. In 1895 I obtained from two typical works—the one American and the other

English—the following details of the wages then current at the blast furnaces, in two leading iron-making districts, and I think the figures of to-day do not greatly differ from them.

	United States.	*United Kingdom.*
	s. d.	*s. d.*
Top fillers....	6. 4½	4.11
Bottom fillers.........	5. 7	4. 7
Cagers	5.11½	4.11
Ore shovellers.........	5. 4½	4. 0
Lime breakers.........	4.11	4. 0

Generally speaking, these figures appear to show, so far as they go, that the wages cost of labor at furnaces in the United States is less than 30 per cent. in excess of that of Great Britain, and, although this figure would be more or less modified by returns collected over a larger area, I do not think that the general result would be greatly affected. But, as we have to account for a difference of 100 per cent. against the United States (dealing still with Mr. Wright's returns), it is manifest that something still remains to be explained.

I have come to the conclusion that in the United States artisan labor costs considerably more per ton of output than in Europe. The wages cost of such labor, to begin with, is much higher. In the two typical cases named, the daily wages paid in 1895 were as follows:

	Average daily rate of wages.	
	United States.	*United Kingdom.*
	s. d.	*s. d.*
Blacksmiths	9. 4	4.7
Machinists	10. 1	5.4
Carpenters	7. 3	4.6
Bricklayers	7.11	4.8

Here we have a difference of nearly 80 per cent. against the United States, for the four items tabulated. But it is also probable that, owing to the harder driving common in the United States, and the much more rapid wear and tear inevitable to the greater rush, the artisan element in the cost of production is much greater in American than in English practice. 'Tis the pace that kills; and neither men or mice are exempt from this rule.

A notable improvement has taken place in the economy of blast-furnace working in all countries since 1890, and I do not wish to be understood as implying that Mr. Carroll D. Wright's figures of 1890 are applicable to the present time. There is no general standard whereby we are able to judge of the extent of that improvement, but in some cases it has been very considerable indeed. In the United Kingdom, for example, I believe that no blast furnaces in 1890 pro-

duced more than 900 tons per week, and perhaps not more than a dozen had reached that figure. To-day we have blast furnaces producing 1,400 to 1,500 tons weekly. I am not aware of any blast furnaces in 1890 that produced pig iron at a lower labor cost at the furnace than three shillings per ton. I know to-day of cases where the labor cost is less than two shillings per ton. It is probable that in the United States even greater progress has taken place. In the interval, at any rate, we have seen the price of southern pig iron brought down from $12 to little more than $6 per ton, and bessemer pig has fallen from about $18 to $12 per ton at the furnaces.

Looking to the future, there is every reason to suppose that a large measure of progress remains to be achieved. What is to be the normal standard of attainment in the future? Is it to be that reached by the new Carnegie furnaces at Duquesne in the United States, that of the new Dowlais furnaces at Cardiff in Great Britain, and that of the Phœnix furnaces at Rubrost in Germany? If so, in all three countries the next decade must witness a large reconstruction of blast-furnace plants. The average output of the furnaces that have been in operation in these three countries for the last three years, as nearly as can be ascertained, has been as follows:

United States............	44,000	tons	per	annum.
Great Britain............	23,250	"	"	"
Germany...............	24,500	"	"	"

But, if all the furnaces in operation were to work up to the figures reached by the three establishments named, the average output per furnace would be:

For the United States.....	182,000	tons	per	annum.
" Great Britain........	78,000	"	"	"
" Germany...........	98,600	"	"	"

Hence we reach the remarkable conclusion that, assuming parallel conditions, we should have an annual output of nine million tons of pig iron in the United States with only 50 furnaces, where 185 are now employed; an output of eight million tons in Great Britain with 102 furnaces, where 350 are now employed; and an output of six million tons in Germany with about 60 furnaces, where 205 are now operated. These figures are not, of course, likely to be realized in actual practice, and are not put forward with that idea, but rather as an indication of the improvement and economy that must be achieved before the blast-furnace practice of to-day can be coördinated with that proved to be possible under the most favorable conditions. This latter qualification is essential, because manifestly so large yields as those of Duquesne, Dowlais, and Rubrost are possible only when rich ores, good coke, and other favorable elements are at command.

EPOCH-MAKING EVENTS IN ELECTRICITY.

By G. H. Stockbridge.

II.—OERSTED.—MAGNETISM AND MOTION FROM THE ELECTRIC CURRENT.

IMAGINE an ancient Greek philosopher, impregnated with the mythologic teaching that made the west wind a living person and peopled the forests with fauns and nymphs and satyrs,—imagine such a man set down among us of this generation, and acquiring a profound knowledge of our modern science and of the useful arts that have been born of it. It is not unlikely that, in the first glow of his wonder at our present comforts and conveniences and our exacter theories of nature, he would be filled with a great regret over the long past, and would exclaim: "Alas! how false it all was! There was no good in it!" On the other hand, for four hundred years the world of scholarship and intelligence has been saying: "How beautiful it was!", and latterly, since science itself has grown wise enough to see it: "How true!" The Greek would be at fault in making what was really beautiful seem less an expression of the truth; it is we who are at fault, if by any undue insistence upon short views in science, or any exclusive or undue glorification of mere formula and fact, we have made the true seem less beautiful. Nothing is more wonderful and inspiring than the achievements of science; few things are duller than the discussions of detached, unrelated fact, which often make up the proceedings of the typical scientific society.

The intense specialization of science is at once the secret of its progress and its danger. The pursuit of small things is apt to make us forget that science has any broad horizons, or any looming seas, or any spring seasons of song and sunshine and dream and prophecy. The thing insisted upon here is that the specific, disconnected facts occupy at present too great a share of scientific attention. They are a part of science, but not the whole of it. It is an honorable distinction to have said something new and true about the Greek genitive, or to have taught rightly that the name of the most virile of the Latin comic poets was Titus Maccius Plautus, and not Titus Accius Plautus. But it would be a pity to overlook the fact that philology has also even greater things to offer; that one may learn from the comparative study of language some of the shyest secrets of mind,—how the languid climate and tropical luxuriance of the orient softened and yet illumined its mode of speech, and how the expression of the stolid north was made sturdier and more uncouth by the hard conditions of existence on the banks of the frozen streams or among the perilous

mountains. Is the Greek telling of the story of man and nature a particle more enchanting in the end than the tale of the latest science when vivified by the imagination, without which all science is futile and fatuous? I fancy that what is lacking to us is the Greek mind, the Greek insight. If it should happen to Mr. Kipling to have directed the poets of our day to dealing, as he himself has lately done, with the most significant realities of the century,—for such the doings of science and invention assuredly are,—he will be certain of an immortality quite independent of his own great contributions to English literature. The Greeks could turn the yellow fruit of the orange tree into apples of gold, but they could not have told why the ripened apple falls to the ground. In the youth of the world, they were, in the main, sensuous and observing, like all youth, but they did not inquire very deeply. After the world had grown old, the falling apple, the swinging lamp, and the revolving sun wrought a profounder inquisitiveness. But all that marked the presence of a new spirit in the world. The modern scientific period had begun.

Remote as all this may seem, it is worth while to note that Greek mythology and modern science have this in common, that they are impressed more immediately and strongly by the phenomena of force or power. The Greeks personified or deified them ; science gives them the precedence of interest and attention. It was not for nothing that the pioneers of modern science, those who ushered in the era of weighing and measuring, the Galileos, the Newtons, and the Keplers, were first led to study the laws of objects in real or apparent motion. Motion stands plainly for power ; if it be a newly-observed motion, it may point to a new source of energy, a prime mover ; or it may indicate a novel translator of energy, a new secondary motor, which always finds a place of importance in the arts. Whether in the youth or the age of the world, humanity displays its kinship with the forces of nature, the sources of power or energy. And one of the most obvious manifestations of power is motion. The device that quiets the child chains no less the attention of man. In a word, the whole world is enraptured of dynamics, of power made manifest.

Volta's apparatus, of which we spoke last month, revealed itself as a new source of electrical energy. The discovery which forms the subject of the present paper arrested attention by reason of the fact that it disclosed a new means for translating the energy of Volta's pile into motion. No matter whether or not the direct applications of voltaic electricity, as in electrolysis, or otherwise, had exhausted themselves ; here was presented a new promise of applicability, which at once became of the highest significance. How well the promise has been fulfilled is told by all the most striking things in recent elec-

trical development. The electro-magnet, which may be looked upon as a natural evolution from Oersted's discovery, was just what was needed to give Volta's "crown of cups" a lever and a fulcrum. Through the combination of the two have come the telegraph and annunciator and alarm systems, and they play an important part in the operation of the telephone, while each, combined with other devices, contributes its part to the success of many useful systems and appliances. Take the electro-magnet alone; this appears as the controlling organ in the dynamo, the electric motor, the ore separator, and the arc lamp, as well as in the appliances already cited.

But we are now concerned with Oersted's discovery itself, its first publication, its laws, and its later development, independent of its relations to other contrivances or its special utilization in the arts.

Hans Christian Oersted, Knight of the Dannebrogian Order, professor of physics in the University of Copenhagen, and secretary to the Copenhagen Royal Society of Sciences, published on July 21, 1820, a brief Latin treatise having the title: "Experimenta circa effectum conflictus electrici in acum magneticam." In that treatise he tells of some experiments which he and his friend Esmarch, the king's minister of justice (who assisted him by invitation), conducted in the presence of a number of learned men. There was "that distinguished man, Wleugel, Knight of the Danish Order, and president of our pilot board"; and Hauch, "that most excellent man, whom the king has decorated with the highest honors"; "that most acute man, Reinhart, professor of natural history; Jacobsen, professor of medicine, a man most skilful in conducting experiments; and the most experienced chemist, Zeise, Ph. D." In the presence of these distinguished men, Oersted, assisted by Esmarch, repeated a series of experiments which the former had performed before his classes the preceding winter. Beyond the fact that Oersted desired to repeat his experiments with improved galvanic apparatus, fitted up by Esmarch and himself, he appears to have been influenced by the wish to put the integrity of his experiments and of his personal claims respecting them beyond question by summoning as witnesses men of the greatest intelligence and honesty of character. He says, it is true, that his earlier experiments "were conducted with somewhat defective apparatus, and so the phenomena which were produced did not seem clear enough for the importance of the subject"; but it is manifest that he anticipated success with the new battery, and that he wished to substantiate the facts in the presence of unimpeachable witnesses.

Having described the exact character of his galvanic apparatus, Oersted proceeds to set forth a number of experiments as follows:

"Let the opposite poles of the galvanic apparatus be joined by a

metallic wire, which, for brevity, we will call the joining conductor, or joining wire. To the effect, however, which takes place in this conductor and the surrounding space, we will give the name electric conflict.

"Let the rectilinear part of this wire be placed in a horizontal position over a properly-suspended magnetic needle, and parallel to it. If necessary, the joining wire can be so bent that a suitable portion of it may assume the position necessary for the experiment. These things being thus arranged, the magnetic needle will be moved, and, indeed, under that part of the joining wire which receives electricity most immediately from the negative end of the galvanic apparatus, will decline toward the west.

"If the distance of the joining wire from the magnetic needle does not exceed ¾ of an inch, the declination of the needle makes an angle of about 45°. If the distance is increased, the angles decrease proportionately. The declination varies, however, according to the efficiency of the apparatus.

"The joining wire can shift its place either eastward or westward, provided it maintains a position parallel to the needle, without any other change of effect than as respects magnitude; and thus the effect can by no means be attributed to attraction, for the same pole of the magnetic needle which approaches the joining wire while it is placed at the east side of it ought to recede therefrom when it occupies a position at the west side of it, if these declinations depended on attractions or repulsions.

"The joining conductor may consist of several metallic wires or bands connected together. The kind of metal does not alter the effects, except, perhaps, as regards quantity. We have employed with equal success wires of platinum, gold, silver, copper, iron, bands of lead and tin, a mass of mercury. A conductor is not wholly without effect when water interrupts, unless the interruption embraces a space of several inches in length.

"The effects of the joining wire on the magnetic needle pass through glass, metal, wood, water, resin, earthenware, and stones; for, if a plate of glass, metal, or wood be interposed, the effects are not destroyed, nor do they disappear if plates of glass, metal, and wood be simultaneously interposed; indeed, they seem to be scarcely lessened. The result is the same if there is interposed a disk of amber, a plate of porphyry, or even an earthenware vessel, filled with water. Our experiments have also shown that the effects already mentioned are not changed if the magnetic needle is shut up in a copper box filled with water. It is unnecessary to state that the passing of the effects through all these substances has never before been observed in elec-

tricity and magnetism. The effects, therefore, which take place in electric conflict are as different as possible from the effects of this or that electric force."

Other experiments are described, giving the results when the joining wire is moved to various positions, or is bent back upon itself, and the outcome is stated of experiments with certain substitutes for the magnetic needle. Oersted finds, for example, that the effects are inverted when the joining conductor is moved from a position above the magnetic needle to a position below it. He learns, too, that "a needle of copper, suspended like a magnetic needle, is not moved by the effect of the joining wire. Also needles of glass," he adds, "or of so-called gum-lac, subjected to similar experiments, remain at rest."

From all this Oersted adduces, as he says, "some consideration in explanation of these phenomena. Among them are the following:

"Electric conflict can only act upon magnetic particles of matter. All non-magnetic bodies seem to be penetrable by electric conflict; but magnetic bodies, or, rather, their magnetic particles, seem to resist the passage of this conflict, whence it is that they can be moved by the impulse of contending forces.

"That electric conflict is not inclosed in the conductor, but, as we have already said, is at the same time dispersed in the surrounding space, and that somewhat widely, is clear enough from the observations already set forth.

"In like manner, it is allowable to gather from what has been observed that this conflict performs gyrations."

Oersted's treatise became known to the scientific world through being sent "to all of the most renowned natural philosophers and scientific societies." Pursuing the hint afforded by Oersted's experiments, Arago soon discovered that a copper wire connecting the poles of a Voltaic cell would attract iron filings. He also discovered that he could communicate permanent magnetism to steel needles laid at right angles to the copper wire; and, following a suggestion of Ampere's, he found he could increase the effects by coiling the wire into a helix, and inserting the needles in the central opening. This was in September, 1820. In the same year Davy achieved substantially the same results in a similar manner. A little later Schweigger invented his "multiplier," by means of which he made the magnetic action more intense through increasing the number of the coils. The invention of the electro-magnet in the form which adapted it for its varied uses is still a matter of considerable doubt. The English claim it for William Sturgeon, who undoubtedly disclosed a practical electro-magnet in 1825, and who probably invented it two or three years earlier. It is certainly true that the disclosure of Sturgeon's

magnet set people to work upon the new device, and that the later improvements rest upon the original form which Sturgeon gave to it.

Everybody knows that the efficiency and utility of the electro-magnet depend upon the circumstance that soft iron becomes temporarily magnetic under the influence of this electric current, losing its magnetism as soon as the current ceases. In this respect it differs from steel, which retains its magnetism after cessation of the current.

By substituting for the steel needles within the helix, in Arago and Ampere's experiments, a core of soft iron provided with a suitable armature, we have practically the Sturgeon electro-magnet. And yet the difference is quite sufficient to mark the birth of an instrument which has an adaptability in the electrical arts altogether without a parallel. In another place I have called it the first of the electro-mechanical powers,—corresponding, say, to the lever among the strictly mechanical powers.

The Sturgeon magnet already possessed powers far beyond the little apparatus which Oersted has described for us. He states, I believe, that it had a lifting power of nine pounds. As improved by Moll, and afterwards by Henry, who wrapped the iron core with many coils of insulated wire, according to the principle of the Schweigger multiplier, the electro-magnet came to have a lifting capacity of many thousand pounds. By this time it was no longer inconceivable that electricity, acting through electro-magnetism, might do some of the world's heavy work, for which it has since shown its capacity. Since the time of the inventors named, the electro-magnet has been made of numberless weights and sizes and configurations, to suit the needs or the whims of whoever wished to say: "Do my work." Perhaps it was Mr. Brush, seeking a regulator for his arc lamps; or Ball, or Edison, trying to separate metallic iron from its ores; or Weston, looking for a special type of dynamo-electric machine; or Morse and Vail, puzzled over the best sort of receiving apparatus for their telegraph; or some inventor of an alarm, annunciator, or other signaling system for house or hotel, requiring a tell-tale device; or Sprague, needing a motor for electric elevators or electric street cars. The electro-magnet adapts itself to all these requirements with unparalleled perfection.

The story of Ampere's deductions from the Oersted phenomena is familiar, but the significance of it may profitably be dwelt upon, since it is the story of one of the most remarkable achievements of human genius. It has been told many times, and may here be rehearsed in the language of Professor Chrystal.

"Scarcely had the news of Oersted's discovery reached France," he says, "when a French philosopher, Ampere, set to work to de-

velop the important consequences which it involved. Physicists had long been looking for the connection between magnetism and electricity, and had, perhaps, inclined to the view that electricity was somehow to be explained as a magnetic phenomenon. It was, in fact, under the influence of such ideas, that Oersted was led to his discovery. Ampere showed that the explanation was to be found in an opposite direction. He discovered the ponderomotive action of one electric current on another, and, by a series of well-chosen experiments, he established the elementary laws of electro-dynamic action, starting from which, by a brilliant train of mathematical analysis, he not only evolved the complete explanation of all the electro-magnetic phenomena observed before him, but predicted many hitherto unknown. The results of his researches may be summarized in the statement that an electric current, in a linear circuit of any form, is equivalent in its action, whether on magnets or other circuits, to a magnetic shell bounded by the circuit, whose strength at every point is constant and proportional to the strength of the current. By his beautiful theory of molecular currents, he gave a theoretical explanation of that connection between electricity and magnetism which had been the dream of previous investigators. If we except the discovery of the laws of the induction of electric currents, made about ten years later by Faraday, no advance in the science of electricity can compare for completeness and brilliancy with the work of Ampere. Our admiration is equally great, whether we contemplate the clearness and power of his mathematical investigations, the aptness and skill of his experiments, or the wonderful rapidity with which he elucidated his discovery when he had once found the clew."

To understand Ampere's work as a logical sequence of Oersted's discovery, let it be remembered that each new advance in the evolution we have endeavored to trace involved new conclusions in respect to the nature of the force which moved the compass needle. Thus, though Oersted's experiments pointed out this force as probably magnetic, they did not show, as Arago's tests did, that the electric conflict would magnetize a hitherto neutral body. The magnetic nature of this stress or conflict being established by Arago, and it being recognized that electric currents were capable of exercising an influence at a considerable distance from the conductors forming their path of travel, the notion of comparing the mutual effects of currents in neighboring wires was not far distant. Ampere's investigations, therefore, concerned themselves not only with the mutual action between an electrical conductor and a magnet, but also with the action of the earth upon a current, and the mutual effect of currents in proximity to one another.

One of the remarkable things about Ampere's work, noted by Chrystal and by everyone else who has investigated the matter, is the rapidity with which he arrived at his conclusion. Ampere heard of Oersted's discovery on September 11, 1820. Seven days later he read a memoir before the Royal Academy of Sciences, discussing the new phenomena, and he continued the subject before the Academy on September 25, and October 2, 9, and 30 following. It is this series of papers, together with some later articles published during the three or four succeeding months, which form the basis of Professor Chrystal's eulogy, and they are now familiar illustrations of the great powers of the human mind.

They occupy about fifty pages of the *Annales de Chimie et de Physique* for 1820. It will be possible here to make only a very brief extract from that portion of the memoirs which contains some of Ampere's earliest conclusions, as follows:

"1. Two electric currents attract each other when they are moving parallel in the same direction; they repel each other when they are moving parallel in opposite directions.

"2. It follows that, when the metallic wires which they traverse cannot rotate in parallel planes, each of the two currents tends to bring the other into a situation where it will be parallel to it, and moving in the same direction.

"3. These attractions and repulsions are absolutely different from ordinary electrical attractions and repulsions.

"4. All the phenomena presented by the mutual action of an electric current and a magnet, as discovered by Oersted, come under the law of attraction and repulsion of two electric currents, as just now enunciated, it being admitted that a magnet is nothing more than an assemblage of electric currents which are produced by action of the particles of steel upon each other, analogous to the action of the elements of a Voltaic pile, and which occur in planes perpendicular to the line which joins the two poles of the magnet.

"5. When the magnet is in the position which it tends to take under the influence of the terrestrial globe, these currents are turned in a direction opposite to that of the apparent movement of the sun, the conditions being such that, when the magnet is placed in the opposite relation, so that those of its poles which look toward the terrestrial poles are of like kind with the latter, the same currents are in the direction of the apparent movement of the sun.

"6. The already known phenomena observed when two magnets act upon each other come under the same law.

"7. The same is true concerning the action which the terrestrial globe exercises upon a magnet, assuming the presence of electric cur-

rents in planes perpendicular to the direction of the dipping needle, moving from east to west underneath the said direction.

"8. There is nothing more at one pole of the magnet than at the other; the only difference is that one is at the left and the other at the right of the electric currents which give magnetic properties to steel.

"9. When Volta had proved that the two electricities, positive and negative, of the two extremities of the pile were attracted and repelled according to the same laws as the two electricities produced by means known before his time, he had not thereby completely demonstrated the identity of the fluids set in action by the pile and by friction; but this identity was proved, so far as a physical fact can be, when he showed that two bodies, one electrified by the contact of metals, and the other by friction, acted upon each other, under all circumstances, as if they had both been electrified by the pile, or by the ordinary electrical machine. The same kind of proof is found here respecting the identity of the attractions and repulsions of electric currents and of magnets. I have just shown to the Academy the mutual action of two currents; the well-known phenomena respecting that of two magnets come under the same law. Taking this resemblance as a starting-point, one could only prove that the electric and magnetic fluids are subject to the same laws, which has long been admitted; and the only change necessary to make in the ordinary theory of magnetization will be to admit that the magnetic attraction and repulsion ought not to be compared to those which result from electric tension, but to those which I have observed between electric currents. Oersted's experiments, in which an electric current also produces the same effects upon a magnet, prove still more that it is the same fluids that act in the two cases."

The list of those who have in more recent times made fruitful studies concerning electro-magnetism would include more names than can find a place here. But Maxwell, Dub, Joule, De la Rive, Faraday, Rowland, Helmholtz, and Thompson deserve mention in particular. The last-named electrician has lately published an extended work on the electro-magnet, which summarizes the results of scientific research on this subject down to the early nineties.

THE CONTROL OF THE LEVELS OF THE GREAT LAKES.

By W. A. Jones.

WITHIN a reasonable time the Mississippi river may be expected to have another ocean outlet *via* the Great Lakes and the Illinois river. There is little doubt that such an operation would lower the level of Lake Michigan,—but how much can only be guessed at. The normal lake level, resulting from climatic influences, is a function of the relation between the rainfall over an imperfectly-defined area and the run-off, or quantity which gets into the streams and lakes. We are not at present equipped with the necessary facts to enable us, even approximately, to state that relation. The water-shed area cannot be precisely stated, and the average rainfall over it is not known. Actual measurements of rainfall are good only for small areas around the points of observation. The difference in precipitation between points not more than thirty miles apart is often considerable. The phenomena which control the relation between the quantity of water that falls as rain and the quantity thereof that gets into the streams are numerous and hardly amenable to precise observation and analysis. A rainfall of one inch may find the earth and atmosphere under such conditions as to absorb all, or nearly all, of it, on the one hand, or very little of it, on the other. Two inches of rain may fall within an hour, or may drizzle along for days in an atmosphere of high evaporative capacity. These are but items in a long category.

So far, our deductions in this matter have been based upon averages. But averages are not what we want. They are rarely, if ever, true statements of what has happened. The truth lies on one side or the other. Commerce on the lakes must be able to cope with something approaching minimum conditions. Where shall we go for the facts on which those conditions depend? Lake levels oscillate between upper and lower limits dependent upon widespread and complex climatic effects. Who can say that either limit has been observed and recorded? The once fertile plains of Babylon are blistered with desert heat. Will the oscillations of climate ever restore them? The lake beds of Minnesota and Dakota furnish evidences of a time of far less precipitation than that shown by any of our records. Why not turn aside from the mist and haze of meteorology, and consider a straight engineering proposition of laying our hands on those waters

and controlling their levels to suit our needs? I believe the lake outlets can be occupied with dams having gates in them through which such greater or less quantities of water may be allowed to pass as will enable the lake surfaces to be held each at a constant level. This level need not be higher than the waters have commonly reached before, and so no damage need be inflicted upon riparian interests. If this could be done, climate could go on its wonted way without filling the commercial mind with anxiety. The Chicago canal could be freely permitted to draw off its ten thousand cubic feet per second without creating apprehension. Consider the effect of giving the valley of the Mississippi two water lines to the markets of the world; of giving the great forests of its lower part a practical connection with the greatest market for manufactured lumber in the world; of raising its beds and mountains of iron ore to bessemer grade by means of ores from Lake Superior; of enabling lake vessels to figure with precision on their working draught.

Suppose a pool of water into which more water is being uniformly introduced. If not already full, it will gradually fill and overflow, until the whole quantity that comes in, less that evaporated, will be discharged at the outlet. The quantity passing out, supposing the discharge to pass through a rectangular notch, will be a function of

$$C\, b\, d \sqrt{2\, g\, h},$$

b and d being its breadth and wet depth, h the head on sill of the section, and C a constant. Now, if we deepen this notch, or section, so as to permit objects of greater draught to pass through it, we increase its discharge capacity, more water will pass out than is coming into the pool, and its level must lower until d becomes small enough to equalize the inflow and outflow. If, however, when increasing d, we decrease b in the proper proportion, the discharge and navigable capacity of the section will remain unchanged. With this state of affairs, if more or less water comes into the pool, its level will rise or lower, and the navigable depth of the outlet will increase or decrease in proportion. It is obviously impossible, with a varying quantity of water coming into the pool, to maintain a navigable channel of constant depth at the outlet. The best that can be done is to ascertain the minimum quantity that any season will supply to the pool, and, for a minimum navigable draught, to adjust the discharge section to that. Passing from pool to lake, it may be observed that the substitution of an actual river wet section at a lake outlet will not materially alter the foregoing general deductions. The play between vertical and horizontal causes and effects will be somewhat modified, but the main results will remain the same. Here again, however, we are face to face with the uncertainty of meteoric conditions. There is no

good reason for supposing that we have record of either a maximum or minimum run-off season, but strong indications that we have not.

Now, to adapt this principle to the interlake channels, let us suppose that we have two pools, or lakes, connected by an ordinary river-channel, through which one discharges into the other. The foregoing discussion, which applies in a general way to sections of river shape, of the discharge at a pool outlet applies to the various points along the river where there is a restricted navigable capacity. If at such a point the section is narrow, with obstructions, a pool will form upon it, until such head is created as will force the passage of all the water that comes. If we remove the obstructions or deepen the section, its navigable and discharge capacity will be increased, and the pool will be lowered. But, if, at the same time, we restrict the width in proper proportion, the two will remain relatively the same. There are cases where the navigable depth is below grade on account of the discharge taking place through a wide, but shallow, section. Operations for improvement here must be confined to deepening and restricting it. If we deepen it alone, a new and lower water surface will be created. The improvement will not be measured by the increased depth given to the section. The navigable capacity of a river is ruled by its minimum sections rather than by its average slope. It is a function of:

(1) The area of its minimum and wide-shallow sections;

(2) The quantity of water which seeks passage.

As before stated, we can measure the former, but cannot, with any sort of precision, determine the latter. Obviously, if we do something towards creating on the Great Lakes and their river connections a more uniform navigable depth,—something that will not leave their stupendous commerce restricted within the *ignus fatuus* lines of meteorology,—we shall greatly further the public welfare.

On all ordinary water lines of transportation created by modifying natural water-courses, the fluctuations of navigable capacity resulting from climatic changes have to be submitted to. Commerce must adapt itself to them, and there is always an element of uncertainty as to how much freight a vessel will be able to carry in the low-water season. The commerce of the Great Lakes, however, is so enormous,—far surpassing that of any other locality in the world,—and its development in proportion to the growth of the whole nation is so probable, that it is a matter of great importance to eliminate as much as possible of this element of uncertainty. I purpose to indicate a line along which we may hope to make such improvement. There are two distinct phases to the question:

(1) The navigable capacity of the lake harbors;

(2) That of the interlake channels.

The level of the water surfaces of the lakes varies with the run-off from their watersheds. I have before me the records of lake levels from 1836 to 1896. The oscillations in each yearly period afford a striking picture of the resultant of precipitating, evaporative, and other absorptive forces. From the lowest point in midwinter or early spring to the highest in midsummer, they follow each other with absolute precision. They reveal a climate where the bulk of annual precipitation occurs before midsummer. These double annual fluctuations from low to high and back again are ordinarily from one to two feet in extent, and occasionally between three and four feet. The extreme oscillation between highest and lowest recorded observations is from -1.5 to $+4.0$ on the gage. Here is a vertical oscillation, from actual measurement, of 5.5 feet. If we assume a minimum level based on these observations, and create entrances to the lake harbors measured from that, we may certainly expect periods of uncertain duration when the navigable depth of these entrances will be below grade. As the matter stands now, this is as much a meteoric question as one of engineering. It is quite evident by this time that, by the method of running out piers from shore and deepening the channels between them, we cannot, with any sort of precision, ascertain what the navigable depth of these harbor entrances is going to be from year to year. Commerce must take its chances, accept what it gets, and make its estimates in the midst of each season's battle.

In the interlake channels we have precisely the same meteoric uncertainty to meet. Here, however, it is aggravated by the fact that the United States has not the right to interfere with the levels of the pools of the lakes or the subsidiary river pools without the acquiescence of the Dominion government.

The existent projects for the improvement of lake harbors have for their object the creation of sheltered holding ground and channel entrances, and navigable depths in the same below an assumed low-water plane. For the interlake channels they seek to give a 20-foot navigable depth by increasing the minimum sections vertically and to a width varying from 300 to 2,400 feet as follows:

In St. Mary's river, at Hay lake, Round island, Little Mud lake, Sailors Encampment, and Mud lake, channel 300 feet wide and 21 feet deep.

At the foot of Lake Huron, channel 2,400 feet wide and 21 feet deep.

St. Clair Flats, from deep water in river to the St. Clair Flats canal, a channel 20 feet deep and converging from 650 feet wide at river to canal width at canal.

Through the canal, 20 feet in depth.

From foot of canal to deep water in Lake St. Clair, a channel 20 feet wide and diverging from canal to a width of 800 feet at deep water.

Foot of Lake St. Clair, channel 800 feet wide, 20 feet deep.

Lime Kiln crossing and vicinity, Detroit river, channel 440 feet wide and 20 feet deep.

Mouth of Detroit river, channel 800 feet wide and 20 feet deep.

In the presence of this description of the projects, and the foregoing general discussion, it is evident that we can make a great improvement by eliminating as much as possible of the purely meteoric factors of the problem. A discussion of the observed lake levels should evolve a desirable one for each lake, by holding which constant, or nearly so, the harbor question would be completely solved. I would occupy the outlet of Lakes Superior, Huron, Erie, and Ontario, with great dams having ample discharge capacity controlled by movable gates. These gates, or weirs, could be set at varying heights to control the levels of the waters above them. The new American beartrap weir has come just in time to enable us to solve the great problem of the lakes. It will enable us also to store sufficient of the surplus water in the lakes as reservoirs, to be always ready to supply any deficiencies in the interlake channels, and, should it at times become necessary, to furnish what may be wanted for the discharge of the Chicago canal. These gates have passed the domain of experiment. Very large ones have been in use on our northwestern rivers for several years. Fig. 1 is an illustration of one designed to control an opening 16 feet in height by 600 feet in width. They can, by a mere operation of the filling or discharging valves handled by one man, be made to carry their crests indefinitely at any desired level within range. Such a dam would, of necessity, require a free discharging capacity about equal to a minimum discharge in its locality. Then, with a part of the water going through the free opening, and a part over the crests of the movable weirs, if more water should come into the controlled area, the weirs could be lowered sufficiently to permit it to pass without raising the level. If less water should come, the weirs could be raised, and the level of the controlled area would have to hold up until such increased head was created as would enable the coming water to get through the restricted area of discharge through the dam. Vessels going down could pass through the free opening without unreasonable difficulty, but those going up would have to be locked through the dam. The locks would have a very low lift, and should not cause much detention, especially if arranged as a pair, one for up-going and the other for down-going vessels.

I have made passing allusion to the international aspect of the

proposition herein advanced. Perhaps the greatest stumbling-block in the way of the necessary concert of action is the conception of a military frontier between the United States and Canada. A considerable portion of the boundary line is merely an astronomical conception. A great circle from the highest heavens, by subtle processes of mathematics, has been projected upon the surface of the earth as a dividing line. It is laid out on the ground by means of imaginary lines connecting certain monuments erected by the joint efforts of the two governments. From one side to the other there is little change of geographical features or industrial possibilities. As a matter of fact, the real boundary is not a line. It is a zone on the American side. The number of Canadians living within that zone is surprising. That silent zone is an everlasting protest against the boundary, against the idea of anything militant existing along it.

And more. By an irresistible law of strategy the people on the other side of that border zone are of a common destiny. Canada is an untenable position for England in the event of a serious clash with the United States. The development of transportation and commerce has revolutionized the strategic conditions along that border. Into and behind the English position there has been thrust the great throbbing heart which controls the pulsations of the inland commercial systems. As a result, any portion of the land forces of the United States can be projected with marvellous rapidity upon the rear of it, and thereafter have ample and secure communications. Why not have a show of hands right here, and end this talk of fight and defence in that quarter? Why not terminate the antiquated discussion about warships on the lakes? We want none there, and can see that no others get there.

Again, the vaunted position of Vancouver island, at the western extremity of the boundary, is also untenable against the United States. Within the sweep of a definite radius swinging around the little cluster of San Juan islands lies the strategic control of the North Pacific ocean and the western coast of the United States. At the point where Puget sound, the Straits of Juan de Fuca, and the Gulf of Georgia come together, a well-protected harbor can be created, having ample facilities of ingress and egress, and here the land and sea power of the United States could be brought together with ease and certainty. As a means of attack or defence against the United States it seems like waste for England to spend money for war purposes in that quarter. The conception of a military frontier between the United States and Canada has no just or solid foundation, and should not be allowed to stand in the way of a long pull together to make the unsalted seas a means of carrying old ocean's commerce into the heart of a continent.

THE RECENT PROSPERITY OF BRITISH RAILWAYS.

By William J. Stevens.

THE results generally displayed by British railways for over eighteen months past have fully justified the hopes of those who, prior to 1895, looked for better things from the companies than they were able to show in the bad years 1893 and 1894. The sudden change from a succession of poor dividends to a period of prosperity which has been witnessed since June 1, 1895, is without parallel in the modern history of the railways of Great Britain. Coming as it did after the exceptionally poor exhibits made in the years 1893 and 1894, as well as in the first six months of 1895, the sudden improvement was, of course, the more acceptable to the shareholders, who, since 1889, had had to bear a practically continuous decline in their profits from year to year.

From 1885 to 1889 was a period of successive improvements in the dividends paid by most British railways, culminating in the distributions of the latter year, which were rather above the average. But after 1889 there followed a number of bad years, each worse than its predecessor, which culminated in the unprecedentedly low dividends of 1893 and 1894. The former of these years was a record one, as regards the paucity of railway profits and the correspondingly low distributions on the ordinary stocks, due, of course, in a large measure, to the protracted strike of coal-miners in the second part of the period, which, besides paralyzing goods and mineral traffic in the Midlands, imposed on all the leading companies an unusually heavy charge for fuel. The succeeding year was rather better than 1893, so far as the English lines were concerned, but for more than three months of that period the Scotch companies had to endure a strike among the coal-miners in the districts served by them, which, so far as the area affected is concerned, was quite as disastrous as the English strike of 1893. The year 1895 was one of mixed influences counteracting each other, so that, on the whole, no material improvement took place. In the first six months both passenger and goods traffic (particularly the former) was adversely influenced by the severe weather then experienced. In the second half of the year the improvement in trade materially helped the companies, and for that period there was a general increase in dividends; but it did not in most cases do much more than make up the deficiencies of the preceding half-year. As a matter of fact, three large companies, the Great

Western, Midland, and North Eastern, each paid lower rates on their ordinary stocks for the whole year 1895 than for 1894.

But 1896, in decided contrast to previous years, was, throughout, a year of marked prosperity for all British railways. Everything seemed to assist them to increase their profits. A very large growth in gross receipts was secured, and continued throughout the year. On the other hand, expenses, though showing large increase, did not call for a relative share of the additional gross earnings, so that net revenue showed very large expansion. Then, to complete the favorable circumstances to the ordinary shareholders, the addition to capital charges during 1896 was remarkably small, so that a very large proportion of the addition to net earnings was paid away in increased dividends on the ordinary stocks. For the three years preceding 1896 the aggregate capital outlay of twenty companies was as follows:

Year.	Expenditure, 20 companies.
1893	£13,165,000
1894	9,977,000
1895	7,568,000

The comparative saving arising from the restricted capital expenditure prior to 1896 was augmented by that arising from the constantly declining rate at which the principal British railways can raise money, thereby accounting for the small increase of capital burdens in 1896.

With the combined force of the favorable conditions referred to above, there is little wonder that there was a large and universal increase in the dividends paid by the companies for 1896. The extent of the recent increase in dividends may best be seen by comparing those paid for the years ended June 30, 1895, and December 31, 1896. Subjoined is a comparison, on this basis, of the distributions made by the principal companies on their ordinary stocks.

Company.	Dividend for year ended June 30, 1895.	Dividend for year ended December 31, 1896.	Increase.
Caledonian	3 7/8	5	1 1/8
Great Eastern	1 1/2	3 1/8	1 5/8
Great Northern	3 1/4	4 1/8	7/8
Great Western	4 5/8	6	1 3/8
Lancashire and Yorkshire	4 1/8	5 3/8	1 1/4
London and No. Western	6	7 1/8	1 1/8
London and So. Western	6	6 5/8	5/8
London, Brighton and So. Coast	5 1/4	6 3/8	5/8
Midland	4 7/8	6	1 1/8
North British	2 1/4 Deferred nil Deferred	* 3 1 1/8	3/4 1 1/8 } 1 7/8
North Eastern	5 5/8	6 3/8	3/4
South Eastern	4	4 11/16	11/16

* Estimated result to January 31 last.

It will be observed that during the past eighteen months the additions to the dividends paid range from ⅝ to 1⅞ per cent. in the case of the twelve leading English and Scotch companies. Among the smaller lines the improvement was equally good, while no company suffered any decline in distribution for 1896 from that of 1895.

The large increase in gross earnings during 1896 may be gathered from the fact that the gross receipts of thirteen leading companies for the period were £68,893,000 against a corresponding figure of £65,-619,000, thus showing an increase of £3,274,000, or about 5 per cent. Working expenses showed an advance in the case of the same companies of £1,583,000, or considerably less than 50 per cent. of the additional gross receipts. The effect of this smaller relative increase in working charges was to reduce the ratio of expenses to receipts for the year by ¼ per cent. as compared with the preceding year. After meeting the increased cost of working, the addition to net earnings was £1,691,000. Of this sum no less than £1,576,000 was actually distributed in increased ordinary dividends by the thirteen companies in question, besides which the sums carried forward to the present year show, in several cases, substantial increases. As a matter of fact, the addition to the capital charges during the past year was only a little more than £100,000,—the smallest increase in this item for many years.

The effect of the improvement in net earnings last year has been to very materially improve the current yield on the capital invested in British railways. As the returns for 1896 are not by any means complete for all the railways of Great Britain, it is at present quite impossible to take a complete survey of the results in this respect; but it will not be difficult to show clearly that a distinct step forward has been taken. For the seven years prior to 1896 the board of trade statistics show the net return on the capital invested in all British railways to have been as follows:

Year.	*Net return on capital.*
1889	4.21 per cent.
1890	4.10 "
1891	4 00 "
1892	3.85 "
1893	3.60 "
1894	3.77 "
1895	3.80 "

As I pointed out in THE ENGINEERING MAGAZINE of August last, the figures given above do not allow for nominal additions to capital, which at the end of 1895 amounted to £88,500,000 out of a gross capital of £1,001,000,000. As a very large proportion of this nom-

inal increase accrued between 1889 and 1895, the decline in the net return was really not so large as it is made to appear. Allowing for this feature, the real decline in the return between 1889 and 1895 was probably not much more than .21 per cent. As dividends have practically been restored to the level of 1890, it is probable that the average net return on the whole capital of the railways of the British Isles will, when the returns are fully complete, work out at about 4.10 per cent. as in 1890, after allowing for the merely nominal additions to capital made in the interval.

For the purpose of ascertaining exactly what progress has been made in the matter of the net return yielded on railway capital in 1896, the actual results of the thirteen leading companies already referred to may be taken. To the end of 1895 the total capital of these thirteen companies, excluding nominal creations, was £618,000,000, and, as the net revenue for the year amounted to £29,214,000, the average yield on the capital invested was 4.73 per cent. At the end of 1896 the total capital of the same companies had increased to £625,700,000, and the net revenue to £30,905,000. The latter figure represented a yield on the capital of 4.94 per cent., an improvement as compared with 1895 of .21 per cent. As the whole of this improvement has gone solely to the ordinary stock-holders, it represents a much larger relative increase on the ordinary capital. Thus, while the total improvement on the net revenue of 1896 amounted to 6 per cent. as compared with 1895, the amount distributed in dividends on the ordinary stocks showed an increase of 15 per cent.

With this general as well as large improvement in the position of the ordinary stocks of all British railways, there is little wonder that the prices of the latter have recently been very high,—record figures in some instances. Not only have dividends already been materially enhanced, but prospects continue to be good, for traffics are still showing progress, and yet further increases in dividends may be realized. A curious feature in connection with the present level of quotations may be noticed at this point. Taking the whole list of British railway junior stocks, the yield on the basis of present prices is materially higher than it was a year ago, taking the prices then ruling and the dividends for 1895. The reason for this is that the level of quotations at the earlier period discounted to a considerable extent the improvement which has now been actually realized, and the prospect of further improvement is of course not so great. Another point in connection with this phase of the subject is that prices are now, in most instances, materially lower than they were six months ago, though in the interval marked increases in dividends have, as already indicated, been secured. For the decline in the face of improved re-

sults, the tendency to over-discount future improvement, which is a characteristic of the stock markets, is largely accountable, though an improvement in the rates ruling in the money market, after a period of abnormal cheapness, as well as recent political unrest, have also been adverse features tending towards lower prices.

In spite of the fact that during the last few months the return on an investment in the junior stocks of British railways has increased, owing to the increase in dividends, on the one hand, and a slight decline in market values, on the other, there is no doubt whatever that the present yield is still low, compared with former years. On the basis of last year's dividends the yield at the present time ranges, according to the character of the stock, from 3 to 4 per cent. on the junior securities, and averages about 3½ per cent. As last year's dividends were, in nearly all cases, rather above the average, the continuous yield which may reasonably be looked for is even less, and does not exceed 3¼ per cent., taking the regular dividend paying stocks together There are a number of the more speculative stocks which yield less than 3 per cent., even on last year's dividends, while a few yield nothing whatever. These, however, always command a relatively high value on account of the speculative favor in which they stand, partly because their low price attracts buyers, and partly because a stock receiving no dividend, or only in receipt of small and irregular dividends, is difficult to value with any precision. Prospective rights carried by them are certainly of some value, but, as in the case of those American railroad common stocks which have, up to the present, been dividendless, a relatively high price is given, even in poor years, for the rights they carry, as contrasted with superior stocks or bonds, ranking ahead of them and actually in receipt of regular income. Stocks of this kind may, however, be disregarded in examining the present yield on the ordinary stocks, for they represent but a small proportion of the total, especially having reference to the market value of the capital involved. As evidence, however, that the rise in railway securities which has brought about the marked diminution of the yield in recent years has, for the most part, resulted from an investment demand, it may be pointed out that the non-dividend stocks and those in receipt of irregular distributions have not by any means reached the comparative heights attained by those stocks in receipt of large and steady dividends.

The high prices of all British railway securities are simply the result of the action of the law of supply and demand. Had the yield on these stocks shrunk as it has done while that obtainable from other securities had remained stationary, the position would indeed be dangerous, and foolish would be those investors who should venture to

face the risks such a position of matters would imply. But the relative superiority of the yield afforded by railway stocks is as great now as it was when "Consols," by example, yielded 3 per cent., although now the latter security yields only 2 per cent., allowing for the fact that the interest declines to 2½ per cent. in 1903 and also for the disappearance of the premium in 1923, when the stock is redeemable at par. All securities of a sound character yield materially less than they did only a few years ago, and the high prices of railway stocks are due to the fact that they have shared in that movement, and nothing more. Whether *all* high-class securities have not appreciated unduly in recent years is a question which it is not necessary to discuss in connection with this matter. A great difference of opinion exists regarding it, though the view of most people capable of judging is that all these stocks must sooner or later come down to a lower level. A great war, a financial panic, or a material advance in money rates would suffice to bring all these securities down from the inordinate heights to which, as the result of a long period of appreciation, they have attained. But surely, granting that such a change must come, it will be admitted that the stocks yielding most at the present time, and withal enjoying good security, will suffer less than those which, yielding a lower return, therefore present a much more vulnerable front to the disturbing influences of a wave of depreciation. This is one great reason why the really good ordinary stocks of British railways are so much sought after at present, and, from the point of view of the permanent investor, who buys a stock in order to obtain as good an average yield as possible, there is much to be said in favor of it, especially while prospects continue good.

As an example of the choice that is before the investor at the present time, let us examine the comparative inducements to purchase, say, London and North Western debenture stock, on the one hand, and the ordinary stock of that company, on the other. In the former case he buys a 3 per cent. stock at 118 per £100, which yields him £2.10.10 per £100. There is no prospect whatever of any improvement on that yield, as the stock is entitled to a fixed rate only, and practically no risk that the return will be diminished. Since 1889 the stock has appreciated by 22 per cent., and, though the quotation was last year as high as 125, there is, on the whole, greater risk of loss than prospect of gain in capital value. As regards the ordinary stock the investor would be able to secure at about 200 per £100 a stock that yields on the basis of last year's dividend £3.11.3 per £100, or 1 per cent. more than on the debenture stock. On the basis of the average dividend for eight years past, the yield would be £3.9.0 per £100. There is the prospect this year of a further improvement in the dividend. Since

1889 the market value of of the stock has increased on balance by only 11 per cent., so that there appears to be greater reason to expect capital gain than loss at the moment, especially with a higher dividend in view. Taking all the facts into consideration, it must be admitted that there is much to be said in favor of the superiority of the ordinary stock as an investment. And the contrast drawn between the debenture stock and the ordinary stock of the North Western Company might be with equal force applied to an estimate of the comparative merits of a purchase of "Consols," colonial stocks, corporation stocks, and other high-class securities, on the one hand, and the better class of railway ordinary stocks, on the other, for in all cases the additional risk incurred by the latter is more than compensated by the higher yield, and smaller prospect of capital loss.

Up to the present the comparative merits of the ordinary stocks have been mainly considered. Their positive advantages remain the same as those which, by long experience, the British investor has proved them to possess. Good and honest management of the companies on which they depend, both commercially and financially, is their strongest point. Then, while under a considerable amount of supervision by the State, through the board of trade, they are comparatively free from harassing legislation, such as has been witnessed in America. The success with which the railways have lately been able to meet in the courts of law various questions in regard to rates has amply vindicated the strength of their legal rights. The long-continued rates-agitation of late years has failed in its purpose of cutting down the charges made by the companies, and has yielded to those who pursued it only apparent advantages in the matter of reduced maximum rates, which have had little practical value, though the companies, on the other hand, have been able, in the course of the consideration of the matter by parliament, to legalize charges (notably terminals) which had not previously the unquestionable sanction of the law. There is no danger of State purchase on Socialistic lines ; the public sense of justice would not entertain for a moment any confiscatory measure of this type. As a matter of fact, State purchase is regarded as a purely academic proposition, and there is no appreciable section of public opinion in its favor.

Another great point in favor of English railway stocks is that the companies are free from the disastrous rate-wars which inflict such injury on American railways. The laws of Great Britain do not forbid pooling arrangements, and, as comparative harmony exists among the companies in the matter of charges, a war of rates is in any form a very rare occurrence indeed. It may be said that the trading community of Great Britain suffers as contrasted with their brethren in America from the higher charges which result from the absence of

rate-wars. But many authorities are of opinion that what is most conducive to the public interests is a steady maintenance of rates at a moderate level rather than the sharp fluctuations in charges due to untrammelled competition. Certainly it may be said that the trading public do not really benefit to anything like the extent that railways suffer in a rate-war. To the maintenance of rates and fares the clearing-house system in Great Britain very materially contributes. It is a well-established, independent organization supported by the companies in the proportions of the work done for them, and, besides dividing receipts from through traffic among the companies, it is a most valuable check on undue competition in rates and fares. The interests of the public are by no means neglected in this matter, and, as evidence that this is so, reference may be made to the reduction of fares lately instituted by several companies to check the decline in second-class traffic. From the beginning of 1895, for example, the South Eastern & Chatham Companies materially reduced their first- and second-class fares. Last year the Great Western and South-Western took similar action, and reduced their second-class fares considerably. According to the general basis on which their fares were framed, the charges were at the rate of twopence a mile first-class, three halfpence a mile second-class, and a penny a mile third-class. Under this scale there has been a constant drain to the third-class, due, no doubt, to the great improvement in the accommodation there given as compared with the superior classes. This was especially the case with the second-class; so the plan of reducing these fares to a penny-farthing a mile (only 25 per cent. more than the third-class) was decided upon, and its introduction in May, 1896, has already yielded a very satisfactory result in the case of both the Great Western and South Western companies. The Brighton Company intends to reduce its first- and second-class fares to the level of two-pence a mile and a penny-farthing a mile respectively, beginning May 1, 1897, maintaining a penny a mile third-class, as at present.

Though competition in rates and fares is alien to the working of British railways, another form of rivalry which, though costly to the companies, is of great benefit to the public, is the competition to improve and increase facilities, both as to speed and accommodation. In recent years this kind of rivalry has made great strides, and to it the increase in the ratio of expenses to receipts is largely due. It is in passenger traffic that its working can be most clearly traced. During recent years there has been a great increase in the accommodation provided in the direction of dining- and drawing-room cars, sleeping saloons, corridor carriages, etc. Even the third-class passenger on the principal trains to Scotland is provided with a dining car without

extra charge beyond that for meals. These additional facilities materially increase the dead-weight of the trains and reduce the earning capacity per train-mile. In addition, the speed of many trains has been increased, involving addition to the cost of working. To haul the heavier trains, more powerful and weightier engines have been constructed, which, together with the high speed maintained, entail a more expensive permanent way. At the half-yearly meeting of the London & North Western Company, the chairman, Lord Stalbridge, referred to this matter. He said: "Owing to the increase in the weight of trains, the speed at which they run, and so on, it has been thought desirable by our engineer to increase the weight of rail. Up to 1885, the 84-pound rail was thought to be heavy enough. In 1885, however, we commenced to lay a 90-pound rail, and that has gone on up till now. We now propose to lay a rail weighing 103⅓ pounds per yard." This, of course, entails an addition to the cost of working, due to this competition of facilities. Under these circumstances it is hardly surprising that the average rate of working expenses has increased since 1889 from 52 to 56 per cent., especially taking into account the addition to such items of expenditure as wages, rates, and taxes. By reason of superior management the effect of this increase in the ratio of working expenses is being overcome, and, as it may be regarded as having, in some respects, reached its limit, there is little danger of ordinary dividends being affected. The lower cost at which the companies now raise capital may be taken as entirely counteracting this.

The most reassuring point about British railway stocks, and one which, above all things, commends them to the favor of the investing public, is the straightforward character of their financial administration. Receiverships, reorganizations, assessments, scaling down of interest on income bonds, and even on mortgage bonds, which so seriously prejudice capitalists against American railroad securities, are phrases which have no application so far as holders of British railway securities are concerned. Railways in Great Britain are not managed with one eye on the stock markets and the other on the interests of their proprietors. A manager who attempted to do anything of the kind would soon have to face dismissal by the board of directors, and anything like disregard for the interests of the proprietary on the part of the latter, with a view to speculative effects, would secure even their expulsion at the hands of the shareholders, who would know how to use, when necessary, the power conferred upon them by the laws of the land. Under these conditions the high prices now current for British railway stocks are not difficult to account for; indeed, it would be surprising if matters were otherwise.

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

III.

HAVING considered the corrosive agents found in boiler waters, and also the individual characteristics of the scale-producing substances, we are now prepared to examine these collectively, and then proceed to a consideration of the various methods for their removal or treatment.

The hardness or softness of water, for boiler purposes, depends entirely upon the quantity of lime or magnesian salts in solution. There are two kinds of hardness in water,—"temporary hardness," due to the carbonates of lime or magnesia held in solution by an excess of carbonic acid, which can be gotten rid of by any method that will drive this off or neutralize it, and "permanent hardness," due to the presence of any soluble salts of lime or magnesium, such as the sulphates, chlorids, and nitrates, held in solution by the solvent properties of the water itself.

The "total hardness" is best distinguished by the fact that, when soap is used with hard water, a certain proportion of it will be destroyed before a lather can be produced, this amount being in direct proportion to the degree of hardness of the water. This destruction is due to the decomposition of the soap by the lime or magnesian salts, and the formation of an insoluble curd of oleate, palmitate, and stearate of lime, or magnesia. By using a sufficient amount of soap the water can finally be softened so that a lather can be formed, but this is a very expensive process, as, according to Collet, the lime salts in a thousand gallons of water will destroy 1.7 pounds of the best hard soap for each "degree of hardness" in the water, one such degree being equivalent to one grain of carbonate of lime per gallon, or its equivalent in soap-destroying power.

Stillman gives (in his "Engineering Chemistry") the following instructions for the determination of the hardness of water.

(1) The preparation of a standard solution of "hard water." "Dissolve 1.11 grains of pure fused calcium chlorid in a little water, and dilute to 1 liter at 60° F.; . . . each cubic centimeter of the solution will correspond to 0.001 gram calcium carbonate."

(2) Solution of soap. "Thirteen grams of sodium oleate are dissolved in a mixture of 500 cubic centimeters of alcohol and 500 cubic centimeters of water, and filtered if necessary." "It now be-

comes necessary to standardize it, so that one cubic centimeter will be equivalent to 0.001 gram of calcium carbonate." This is effected by taking a definite volume of the standard hard water just prepared, measuring accurately the amount of soap solution which must be added before a permanent lather is formed, and then diluting the soap solution, if necessary, until it shows the proper proportionate strength.

(3) Determination of the total hardness. "58.3 cubic centimeters of the clear sample of the water to be examined are run into a 250-cubic-centimeter flask, and the standard soap solution added in the manner described above, until a lather capable of persisting for five minutes is produced." "The number of cubic centimeters required, minus one cubic centimeter for the water itself, will give the degrees of hardness in terms of calcium carbonate in grains per U. S. gallon." "If the water contains a fair proportion of magnesian salts, there will be some difficulty in obtaining the right point, owing to the slowness with which magnesia salts decompose soap; an apparent persistent lather is formed, which, on being allowed to stand a little while and again shaken up, will disappear; a little experience with magnesian hard waters will familiarize the operator with this peculiarity."

The "permanent hardness"—*i. e.*, that which is not due to the presence of the soluble bicarbonates of lime and magnesia—is determined by a substantially similar test made upon the water after boiling it for half an hour. The "temporary hardness" is the difference between the "total" and the "permanent."

"The French standard of hardness of water is stated in terms of milligrams of calcium carbonate in 100 grams of water, or, parts calcium carbonate per 100,000 parts of water."

"The German standard represents milligrams of lime in 100 grams of water, or, parts lime per 100,000 parts water."

"The English standard represents grains of calcium carbonate per gallon of 70,000 grains" (the imperial gallon).

"The American standard represents grains of calcium carbonate per gallon of 58,381 grains" (the United States gallon).

Scale, or incrustation in boilers, is formed by the settling of matter originally held in mechanical suspension, or, more frequently, by the settling of precipitations from chemical solutions.

As we have seen, precipitation from solutions is caused, first, by the expulsion of gases which, when present, held these matters dissolved, and, second, by the simple concentration of solutions beyond their point of saturation.

Incrustation, strictly defined, refers merely to hard crusts of boiler scale, but in boiler parlance it is made to include all precipitation oc-

curring in boilers, from the soft, slushy mud to the very hardest scale. The coherent crusts found in boilers differ widely in hardness and tenacity. Some of these may be crumbled between the fingers to a powder, while others form a hard, compact, porcelain-like scale, which resists the chipping tools or chisels even more obstinately than the very metal of the boiler itself. The scale is very seldom uniform in composition; it usually consists of successive layers, each differing from the deposit above or below it. Some scale is very porous, and the water and steam seem to have little difficulty in finding their way through it, while other scale is solid, compact, and entirely impervious.

The preceding article considered the most important scale-making matters, traced them back to their source of supply, and studied their individual characteristics. We now come to their behavior inside the boiler.

Free floating matter in boiler waters, to which reference was made in Part II of this article, is apt to make no little trouble, as in most cases it is composed principally of clay, which forms a cementing material for the matter already precipitated, so that the result is generally a hard scale resembling Portland cement. The size and character of the particles of earthy material differ considerably, and this governs their time of precipitation. After heavy rains, larger particles are generally found in suspension, while, when the source of water-supply has remained undisturbed for some time, this sedimentary matter often disappears entirely.

The larger and heavier the particles are, the more rapidly they will settle, but the finer particles will be held for a long time in suspension by the circulating currents of the boiler, and often will not settle until these currents are diminished, or cease altogether; this condition may be attained (in factories) during "noon hour," over night, or on Sunday. This will partially explain why boiler scale so often occurs in successive layers.

Vegetable matter is, of course, lighter than the earthy material, and therefore remains longer in suspension, but it finally settles when the water in the boiler is at rest, or nearly so. It also serves, in some cases, to bind the previous precipitate into a hard mass, while, in other cases, it prevents the formation of such hard crusts. Organic matter, as a general thing, discolors the scale, giving it a black or dark-brown appearance.

When the temperature of a solution containing the bicarbonates of lime, magnesium, or iron is raised to 180°, a considerable percentage of these salts is precipitated, while at a temperature of 290° the precipitation is complete. Thus it can readily be understood that the dis-

solved carbonates will be deposited in the boiler; but this precipitation is not instantaneous.

When a precipitation of carbonate of lime or carbonate of magnesia takes place, tiny crystals are formed, so minute that, notwithstanding their being specifically heavier than the water, they remain suspended for a long time before settling, especially when the circulating currents in the boiler keep them in motion. At this stage these crystals have no tendency to agglomerate, but remain floating freely in the water, like so much flour. When first separated from the solution, they generally rise to the surface of the water, forming a scum of more or less thickness and density; but gradually they seem to grow heavier, sometimes adhering to the other impurities in the water, and then they settle slowly to the bottom of the boiler, unless arrested in their course by tubes, or flues, or other boiler parts.

This settling takes place where the circulating currents are the weakest; when the boiler is put out of active service, and the circulation slackens and eventually ceases, it becomes general.

The soft, slushy mud which is thus produced will not form even a soft coherent scale, unless the boiler is emptied of its water while hot, in which case the heat from the boiler itself, or from the surrounding brick work, bakes the mud into a solid mass much more difficut to remove. If attacked while soft, it can easily, in most cases, be washed out with water from a hose or swept out with a brush.

The hard scale formed from this precipitate is a white, porous crust, having comparatively little tenacity. When these carbonates occur in considerable quantity in boiler waters, the water often becomes sensibly thickened by the precipitations, and this interferes not a little with the free escape of the steam. The action of the steam bubbles rising through this thickened water is not at all dissimilar to that occurring when we attempt to boil milk, mush, or oat meal. In such operations the cooks know that they must keep up a constant stirring to liberate the imprisoned steam and assist the convection. If such stirring is omitted, the contents will become attached to the vessel, and both contents and the bottom of the vessel itself will soon be burned. In the boiler the steam struggles similarly to reach the surface, where it finally breaks out with a small explosion, throwing upward with considerable force small drops of water along with particles of the suspended material.

In the boiler these often pass off with the outrushing steam, thus causing serious priming, or foaming, and many of the small globules of water entrained in the steam enclose a minute crystal of the solid matter. This is eventually dropped in the steam piping, or the valve chambers and cylinders of the engines; and thus we are able to account for the white, solid incrustations sometimes found in these places,

and also for some of the undue wearing of the valves, pistons, and their seats or bearings.

Concerning the effect of the deposit from such precipitations on the bottom of boilers, President Allen, of the Hartford Steam Boiler Inspection and Insurance Company, says: "It has generally been supposed that a deposit in a soft state caused little or no injury to a boiler; but our experience has proved conclusively that the contrary is true." . . . . "A deposit of slush or sludge collects on the bottom of boilers and around the seams, and, in fire-box boilers, around the furnace sheets and around the water legs." "The presence is detected by leakage at the seams, fractures at the edge of the plates and in the line of rivets, and by overheating and consequent depression of the plates where it rests." . . . . "This difficulty is greatly aggravated, if grease finds its way into boilers; the grease appears to combine mechanically with the carbonate of lime, and sinks on the plates when the boilers are at rest." "It becomes a loose, spongy mass, which is not carried off by the circulation; but, by its contact with the plates, it keeps the water from them, and, by offering resistance to the free transmission of heat, causes overheating and burning of plates." "Before we had fully investigated this subject, our opinion was, in many instances where boilers were leaking badly and showed indications of having been burned, that it was caused by the carelessness of the engineer in starting his fire with no water in the boiler."

Where the carbonates are present in boiler waters in any appreciable quantity, the blow-off cocks should be opened with more or less frequency, according to the amount of matter precipitated. The "surface blow" or scummer is effectively used to remove the scum from the surface of the water before it has time to settle, while the "bottom blow" is used to remove the mud from the bottom of the boiler. We will take up this matter in greater detail later.

We have thus far considered merely the soft friable scale formed by the precipitation of the carbonates alone; a much harder scale is frequently formed by mixture with other precipitated matter. Clay, settling with this salt of lime and magnesia, forms a cement-like mass; the hydrates of lime and magnesia, occurring with the carbonates, also cement them into a hard, compact scale, difficult to remove; but nothing seems to have so strong a binding effect upon them as the sulphate of calcium. Its long, fibrous crystals are frequently seen binding these carbonates into a solid compact mass, and, when these gypsum crystals lose their water of crystallization by the heat, and become anhydrite, the scale becomes all the more solid and difficult to remove.

When the carbonate of lime, or of magnesia, is precipitated in contact either with the hot metal of the boiler, or with hot piping, or with the previously-deposited scale, crystals are formed, which adhere to such surfaces with some tenacity.

From what has been said, it will be seen that, when a carbonate of lime or carbonate of magnesia scale (separate or together) is formed, some cementing substance must be present to bind it into its solid form, if it has not been *baked* into the crust.

We have considered carbonate of lime and carbonate of magnesia together, on account of their similar behavior; but lime is more frequently found as a carbonate in scale, not only because of its greater abundance, but also because the bicarbonate of magnesia is generally precipitated as a hydrate, forming a powerful cement. Should the hydrate of magnesia be accompanied with a precipitate of sulphate of lime, the hardest kind of scale will form. A scale of this kind, analyzed by Silvester, had the following composition:

	Percentages.
Carbonate of lime	2.490
Sulphate of lime	74.280
Magnesium hydrate	18.000
Alumina and oxid of iron	1.276
Silica	1.83c
Organic matter	2.124
	100.000

This was a very hard scale, which had to be chipped from the plates.

The bicarbonate of iron is seldom found in boiler waters in excess of a grain per gallon. It is so very unstable that it is precipitated, the moment it enters the boiler, as hydrated oxid of iron; it is scarcely worth further consideration here.

Of all scale-formers doubtless none give greater trouble than the sulphate of lime. Its maximum solubility, as already stated, is at 95° F., while at a temperature of 302° it is practically insoluble. In consequence of this fact, whenever water containing this salt is fed to a boiler with 55 or more pounds' steam pressure, nearly all the salt is precipitated. The solution depends entirely upon the solvent power of the water itself, and not upon the presence of gases; the water, therefore, seems to part with the sulphate of lime more reluctantly, and considerable time is required to effect this precipitation by heat.

Very-low-pressure boilers may be operated without much trouble,

even when this salt is present, provided they are blown off sufficiently to prevent too great a concentration; but, even without this concentration, a certain amount of precipitation of sulphate of lime always takes place, causing more or less hardness in the scale.

The precipitated sulphate of lime appears in crystals somewhat larger and considerably heavier than those formed from the carbonates, and consequently settling much more rapidly. They form a semi-crystalline scale so hard and solid that it can be removed only by use of the chisel and chipping-hammer.

The binding effect of sulphate of lime upon other scale matter is due to a change in crystalline structure. This salt is precipitated in the form of small angular crystals as the hydrous sulphate of lime. As soon as it reaches the heating-surface, the heat drives off the water of crystallization, changing it to an anhydrous sulphate, at which time the crystals alter their form to a fine needle-shape. These adhere to each other, or else, scattered through the previous or accompanying deposits, bind them into a solid mass.

Some have stated that, owing to its solid, compact structure, sulphate of lime will transmit heat better than the looser or more porous scales; practice does not confirm this, as more burned tubes and plates are found under this hard scale than under the softer variety, unless the latter contain oil; of course, a great deal of such trouble must depend upon the temperature or intensity of the fire, a forced fire having a tendency to make any scale harder, and, of course, it taxes a given amount of heating-surface with a greater duty in transmitting heat to the water.

Silica is never dissolved in large quantities in boiler waters, and, therefore, as a rule, only a very small percentage of it is present in boiler scales, although it is contained in a majority, and often in combination with an equally small amount of alumina. Occasionally, when present in certain waters containing but little of the other impurities, it will accumulate in time, and form a large percentage of the scale. In such cases, after long runs without cleaning or blowing, it first forms a jelly-like paste, gradually changing under the effects of heat into a white, laminated mass with an undulating surface, which may be detached from the boiler surfaces by scraping. Finally, the heat bakes it into a hard, dense, resisting crust, which only hard chipping will remove. When this silicious jelly is deposited with other impurities in any appreciable quantity, it passes through the above-described changes, and tends to bind the mass into a hard scale.

Silica is easily precipitated by simply boiling the water at atmospheric pressure, and it is for this reason that we occasionally find it forming a considerable percentage of the scale in low-pressure boilers

where sulphate of lime is the principal other impurity. Chlorid of magnesium, owing to its instability at boiler temperatures, will gradually decompose and precipitate magnesium hydrate, the cementing effect of which, when mixed with other precipitates, we have considered. This salt, however, is soluble, and will remain in solution for some time before decomposing.

Practically speaking, we have now considered all of what Silvester classifies as "direct scale-formers" under ordinary working conditions. There remain for our consideration the "indirect scale-formers."

These consist of the various impurities in boiler waters which remain in solution under ordinary working conditions, and include the sulphate of magnesium and also the chlorids and nitrates of calcium, sodium, and potassium.

The individual characteristics of these salts have already been considered in the preceding article, and very little more remains to be said. It will be seen that they are all more or less soluble and are not precipitated unless by concentration of the solution; and, generally speaking, in the quantities usually present in boiler waters, they have very little effect upon the character of the scale.

After examining scale from boilers, many remark upon its stratified appearance, and ask why it is that such a variety of layers is found in a single specimen. This is easily explained.

The character of many feed-waters changes from time to time. In running streams, after rains, the water is often muddy while at other times it is clear. In large rivers, as, for example, along the lower Mississippi, the dissolved impurities are constantly changing, according to the geological character of the country from which the river receives its chief supply, this being regulated by flood and drought in the various sections forming its water-shed.

As these varying waters are fed to boilers, of course the deposited impurities must change. Well-waters also are likely to vary from time to time.

When several impurities occur in a boiler water, the kind of material precipitated depends mostly upon the temperature or degree of concentration. Thus, should we fill a boiler with water containing mechanically-suspended matter, this matter will gradually settle to the bottom, forming one layer; next, if the water be heated to 212°, much of the carbonates will be deposited; and, if afterwards the temperature be raised to 300°, the sulphate of lime will be precipitated. By neglecting to blow off the boiler, we may concentrate some one of the solutions of a very soluble salt beyond its point of saturation, when another precipitation takes place. During all of this time much light

floating matter will be held in suspension by the circulating currents, and, when we finally draw our fires and the water comes to a state of rest, this will settle, and another layer be formed.

To the experienced eye there is much instructive information in boiler scale, principally as to the manner in which the boiler has been handled. Little is to be obtained from it, however, to guide one in treating the boiler water, although it is frequently very useful when considered along with the water analysis; in this connection it is sometimes desirable to analyze the scale; but the more logical and useful course is to analyze the water before it enters the boiler.

The greatest deposit of scale seldom occurs directly over the fire in horizontal boilers, as the rapid circulation of the water above this part tends to keep the floating matter in suspension. These circulating currents always move toward a part of the boiler where the heat (in contact with the boiler surface) is less intense, and the movement of the water diminishes as it approaches such parts, thus allowing the floating particles to deposit. In consequence, we always find the thickest deposit where the heat is least intense, or where the water in the boiler is the quietest. Feed and blow-off pipes frequently hold water at rest for long intervals, thus allowing deposits to line their inner surfaces and reduce their size. These coatings are sometimes but a small fraction of an inch in thickness, while in other cases they may entirely choke up the pipe.

Scale of more or less thickness and hardness frequently forms around boiler tubes and other parts above the fire sheets. Expansion and contraction of the boiler, or the use of solvents which "rot" away such scale, cause it to fall in solid pieces. These pieces often lodge between the tubes, interfering seriously with the circulation of the water, but more frequently they drop upon the fire sheet and prevent the water from reaching that part of the sheet immediately beneath them, often resulting in serious overheating.

Sometimes, when a large number of these cracked-off pieces fall upon a lower sheet, and a deposit of scale-making material follows them, they are cemented into a dangerous crust.

It has been contended that a deposit of scale in a boiler is a good thing. This may be true of a deposit no thicker than an egg-shell, but only when the water contains corrosive agents which attack the boiler parts; and, in order to serve its purpose, the deposit must be evenly distributed over the entire surface to be protected, since, if a few small patches be left uncovered, the corrosive agents will concentrate their effort on these places. I have already spoken of the use of such a deposit where pitting is taking place.

It has been my experience that, where a slight scale is to be al-

lowed to protect the interior boiler surfaces, the man in charge is very apt to permit a much thicker coating to form than is desirable. This is often very dangerous; besides, with such a coating on the interior of the boiler, it is impossible to make proper inspection, such a scale frequently hiding serious corrosion and wasting.

The best way to overcome such difficulties is by a proper treatment of the water; then the dangerous scale will not be formed in the boiler.

I have often been asked "how many grains, per gallon, of scale-making impurities a boiler water may hold without being considered bad." A direct general answer to this question is almost an impossibility. So much depends on the nature of the impurities that their mere amount can hardly be a measure of fitness. A water may hold as high as fifty grains per gallon of some of the very soluble salts, and still be a very good boiler water, while the presence of one-tenth of this amount of sulphate of lime would cause considerable trouble. Silvester has attempted to make a general classification of this kind, as follows.

"Less than 8 grains of incrusting solids per gallon (carbonate of lime, carbonate of magnesia, sulphate of lime, chlorid of magnesium, etc.) .... Very good

8 to 15 grains per gallon	Good
15 to 20 " " "	Fair
20 to 30 " " "	Poor
30 to 40 " " "	Bad
Over 40 " " "	Very bad.

In many steam plants the steam, after being used, is condensed, and the water thus obtained is fed back into the boiler.

Oil, which has been used to lubricate the steam cylinders, is often present in water so condensed, and it is probably the source of more trouble in steam boilers than any other feed-water impurity; certainly it is more difficult to remove or treat.

In ordinary practice, an oil cup or lubricator is screwed into the steam pipe very near the engine, and from it oil is introduced into the entering steam and carried by it into the cylinder, where the greater part of it is supposed to reach the cylinder walls, the piston rod, and other rubbing parts. The amount of oil thus introduced varies greatly in different plants, the conditions governing the quantity being the design of the lubricator, the design of the engine (some requiring more oil than others), and, last, but by no means least, the notions of the man who operates the plant (some engine tenders insisting on flooding their cylinders with oil).

When oil is thus fed into the steam, much of it doubtless enters the cylinder in the form of minute globules held mechanically in suspension, while the balance is changed to a vapor by the heat. The velocity of the steam entering the cylinder and that of the exhaust steam rushing out of the cylinder doubtless carries along with it a considerable percentage of the mechanically-suspended oil, and the fall of temperature between the times of admission and exhaust also, doubtless, causes some of the oil vapor to condense back into the liquid form again, and thus add to the amount of suspended oil in the exhaust steam.

A certain amount of the oil vapor must also pass off with the exhaust steam. Exhaust steam contains, too, a very perceptible percentage of condensed steam—*i. e.*, water—mechanically suspended, and the oil seems to be greatly attracted to the surface of these small particles of water, forming a film or envelope, which coats their exterior surface. We now have before us the three different forms in which oil occurs in exhaust steam,—namely, as solid globules, as a vapor, and as a film coating the small particles of entrained water. The vapor is undoubtedly the most troublesome, as it will flow along with the steam until its temperature is reduced to a point where either it, or the steam which carries it, is condensed.

Again, as this vaporized oil is carried along so easily with the current of steam, a large percentage of it must escape with the exhaust, and thus its lubricating effect is very materially lessened.

It is now easy to understand that the larger the percentage of oil vaporized when it enters the steam, the greater will be the quantity required to secure the necessary lubrication.

The cheaper grades of cylinder oils are generally composed of a mixture of mineral oil (which has not been sufficiently deprived of its most volatile constituents) with some of the animal or vegetable oils, added to increase the viscosity. These last named oils vaporize at comparatively low temperatures, and therefore are not fitted for cylinder use with the present high steam temperatures. Indeed, for every reason, cheap cylinder oils are the poorest kind of an investment.

After leaving the steam cylinder, oil may reach the boiler in several different ways: the steam may pass through a condenser, and the resulting water may pass to a hot well, to be picked up by the pump and put into the boiler,—very common practice in marine work; the exhaust steam may be sent through a heating system, and the condensation returned to the boiler; open feed-water heaters may be used, in which the exhaust steam is sent through the entering feed water, losing at least a part of its oil, which necessarily

accompanies the feed to the boiler; or, exhaust-steam injectors may be used to feed water to the boiler, any oil in the steam entering the boiler with the water.

After entering the boiler, the oil, being much lighter than the water, floats on the surface, the minute globules coalescing so as to form an oily scum.

We have already seen that, when the dissolved salts in the boiler water are precipitated, their first tendency is to rise to the surface, and thus the oily scum, which usually occurs in isolated patches, collects these floating particles, clinging to them tenaciously until it becomes too heavy to float, and gradually sinks until it reaches a tube, a flue, or the shell, where it becomes firmly attached on account of its sticky character, and forms the most dangerous of all known scales. It is entirely impervious to water, and, as it is also a very bad conductor of heat, it allows the metal beneath to become overheated, even to redness, and a bulge, pocket, or rupture occurs. In the case of flue boilers, a collapsed flue generally follows such a deposit of oil, while, in the case of fire-box boilers, it is by no means rare to have the crown sheet "come down."

The floating patches of oil in boilers may vary in size from the area of a small coin up to nearly the whole water surface. On account of the resemblance, some have termed these sinking patches "oil pancakes."

These oily deposits are not always found on the top of flues or tubes; they also occur on the bottom and sides, the place of deposit being determined by the position of the patch before deposit. If it is rising on the surface of the water, it is apt to be deposited on the bottom, while, if falling, the reverse will be the case.

The appearance of this oil scale varies considerably. Sometimes it has a mud-like consistency, varying from a light grey or fawn color to a brown, or even black. Most of these scales have a soft, springy consistency; and this is especially true of another form of oil scale, very leathery or "soft-rubber like" in appearance and feeling.

This last is the most dangerous of all oil scales. After lying for a while in close contact with the hot sheet, gases are generated which will inflate the original deposit (which may be less than one thirty-second of an inch thick) to several times that thickness, and the new porous scale thus formed is even a worse conductor of heat than the original one. The sheet beneath such scale becomes red-hot, and then, being unable to withstand the pressure of the steam, it bulges or blows out like a soap-bubble, and finally rupture takes place. In the meantime, the great heat beneath this oil scale burns out the organic mat-

ter, and in consequence subsequent examination shows only a comparatively harmless scale.

There is a most erroneous opinion that marine boilers are much better adapted than any other form for oily feed water. The reason why they give less trouble from oil is simply that the water in them is generally more or less salt (due to leaky condensers if to no other cause), and the superior densityof the water prevents the oily scale from settling.

Great care must be observed in blowing off boilers containing oil. If the bottom blow is used, the floating oil must descend as the water is lowered, and thus become attached to the boiler surfaces. This has occurred, and the result has been, almost invariably, that the parts covered by this oil deposit have become overheated, and a general collapse of the boiler has followed. All boilers supplied with oily feed water should be provided with a surface blow, and this invariably should be opened by first causing the scum of oil to collect on the surface of the water; after this, the lower blow-off cock can be opened with safety.

On account of the ruinous effect of the oil, engineers' attention and ingenuity have been taxed to the utmost to produce some method or device for effectually removing it from the exhaust steam or from the feed water. If the lubricant used in the cylinder were either an animal or vegetable oil, the water in the hot well might be treated with potash or soda, which would saponify the oil, and the resulting curd might be removed by mechanical means; but, unfortunately, this treatment is seldom applicable, as the base of most cylinder oils is mineral oil, which cannot be saponified. It is, therefore, necessary to resort to some mechanical process applied directly to the oily water. Two methods of treatment are in general use,—skimming and filtration.

In the concluding article on this subject, which will appear next month, various devices for effecting this purpose will be described and illustrated, in connection with the general exposition of apparatus successfully applied to the removal of the direct and indirect scale-making impurities in feed-waters.

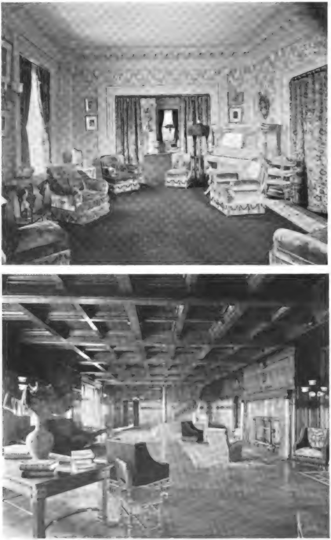
THE ARCHITECTURE OF AMERICAN COUNTRY HOMES.

By H. Neill Wilson.

EVERYTHING in nature seeks in its environment the shelter or home that is individually its own. From the snail carrying her habitation upon her back to the fowls of the air; from the mole and rabbits burrowing under the earth to the larger animals seeking their lairs in mountain fastnesses,—the creature is led by instinct to find for itself an abiding-place, and to build or select that shelter which is adapted to the needs of the life to be lived therein.

Only man, the highest form of animal life, has, from age to age, changed the form of his habitation, and it is curious to note, in reviewing the past, the evolution of the home. Progress in every form has pushed us from the rude shelter of tents and boughs, log cabins, and huts of mud and wood, to the lofty buildings that to-day tower in the metropolis and fill many of us with apprehension as we gaze upward, optical illusion leading us to see them apparently swaying in space, threatening death and destruction to all beneath.

IN BERKSHIRE. RESIDENCE OF E. POPE SAMPSON, PITTSFIELD.



HALL AND DRAWING ROOM, L. F. BECKWITH'S RESIDENCE, STOCKBRIDGE.

PITTSFIELD, MASS. HOME OF GEORGE H. LAFLIN.

It has been left to America to illustrate in domestic architecture, in infinite variety, the uses of wood in house-building. One of the first impressions made upon a foreigner is this multiformity in the wooden construction of the dwelling-houses of America. Nearly every

CHARLES ASTOR BRISTED'S RESIDENCE.

NORTH ADAMS, MASS. RESIDENCE OF A. C. HOUGHTON.

order of architecture has been reproduced in wood, to the bewilderment of men who have studied their profession in countries where stone and brick are universally used in building.

America, if it did not inaugurate, may be said at least to have amply exemplified the wooden age in architecture. Criticism in regard

LENOX, MASS. RESIDENCE OF DAVID WOLFE BISHOP.

to this prevailing use of wood varies with the nationality of the critic. If he be English or Scotch, he is appalled by the apparent lack of stability. The Frenchman is amused at the ornate nature of the ambitious reproductions in wood of that which, he conceives, should be built only in stone. Germany is more lenient toward American peculiarities, owing to having long been well-versed in the adaptability of wood in architecture, and also owing to the German temperament, which is endowed with a commendable degree of toleration and a great spirit of criticism, the result of which is seldom given unsought.


"THE HOMESTEAD," FORMER RESIDENCE OF A. P. STOKES, LENOX, MASS.

The reign of wood, however, is gradually being superseded, even in the United States, and the stone age in architecture is advancing with remarkable celerity. In the not far distant future the new continent may even gratify that most severe critic, Mr. Ruskin, and boast of, and luxuriate in, its ruins! Should fire, storm, or earthquake visit Biltmore to-day, the much-admired result would be obtained, and time, which moulds and softens every outline, would soon produce the imperfect, and consequently the picturesque, which Mr. Hopkinson Smith declares so necessary to the landscape. "It is only," says he, "when the hand of man smirches the face of nature that we really find the picturesque."

Probably no locality is more famed for its summer or country homes

DINING ROOM, RESIDENCE OF CHARLES ASTOR BRISTED.

"SHADOW BROOK," THE ANSON PHELPS STOKES PLACE, LENOX, MASS.

THE SOUTH FRONT OF "SHADOW BROOK," LENOX, MASS.

than Berkshire county, Massachusetts, and a few illustrations will show, better than the most extended critical comment, what study and thought have been expended and what results accomplished. Lenox, Stockbridge, Great Barrington, Williamstown, Pittsfield, and Dalton are represented; yet there are so many others that are worthy that one must resort to that very charming and healthful recreation and go a-coaching or a-wheeling through the Berkshires to obtain an adequate idea of its beautiful and charming country homes.

The best illustrations of the Colonial American style in Lenox are the Appleton and the Frelinghuisen houses; these are so complete and satisfactory that one hardly notices the superb surroundings, but sees only the beautiful in the buildings themselves,—an unconscious and silent tribute to the skill and refinement that produced them.

RESIDENCE OF H. H. COOK, LENOX, MASS.

Another notable house is the H. H. Cook house in Lenox; while one associates this style with a situation upon the border of a lake protected from the violence of winter-storms, and expects the accompaniment of forests and beautiful reflections and sounds of rippling water, the grand view here secured from the higher grounds almost compensates for the absence of other charms.

"Shadow Brook," the summer residence of Anson Phelps Stokes, is probably the most extensive of the many large houses in the Berkshires. This house, built of stone, timber, cement, and tile, situated on the hillside, with the forest of grand old chestnut trees rising be-

HOUSE OF C. M. SMITH, WILLIAMSTOWN, MASS.

A PART OF THE H. H. COOK RESIDENCE.

HALL IN "THE HOMESTEAD."

HALL IN ANSON PHELPS STOKES'S RESIDENCE.

BALL ROOM IN "THE HOMESTEAD."

OAK HALL IN "SHADOW BROOK."

hind it, and overlooking the valley and lake below, and with superb views from all its many rooms, suggests the Old English, which was built by generation after generation with but little regard for what had gone before. The color of the timber-work is a soft brown that is very attractive; the effect was secured by burning the entire exposed surface, leaving the brown and black the natural fire colors.

Elm Court is an example of note; it is situated on high ground, between Laurel and Mackenack lakes, commanding as fine a view as any in the region, and is built of white marble and wood. "Interlakes" is built upon a site similar to that of Elm Court, and has the same grand view. The residences of Henry W. Bishop and Mr. W. A. Whittlesey, of Pittsfield, are illustrations of village and town houses that are well known,—the former being entirely of wood, the latter of brown stone and wood.

PITTSFIELD, MASS. HOME OF HENRY W. BISHOP.

The illustration of the billiard-room is from Blythewood, on Lake Onota, the country house of Mr. Wirt D. Walker, which surpasses perhaps any country seat in this region in beauty of views and surroundings as well as in area. This house is a curious combination of three old buildings, the center of which is conceded to be the oldest house in Pittsfield; from it many interesting old relics were secured and worked over. The house of Hon. Zenas Crane, of Dalton, is a

AN INTERIOR IN THE WHITTLESEY HOUSE.

HALL, W. A. WHITTLESEY'S RESIDENCE, PITTSFIELD.

THE BLYTHEWOOD BILLIARD-ROOM; RESIDENCE OF WIRT D. WALKER.

most interesting one from its situation on the low land, with its streams, lakes, and old trees, and a background of mountains and forest, presenting a most attractive and hospitable appearance.

The illustrations from Williamstown are sufficient to show that the same character and styles pervade the entire region. The Smith house (p. 254.) is in Colonial of the New England type, and distinctly different from the other buildings illustrated. The Procter house, built within

RESIDENCE OF HON. ZENAS CRANE, DALTON.

RESIDENCE OF H. T. PROCTER, WILLIAMSTOWN, MASS.

a year or two, is another example of the Colonial style; while denied the grand and extensive views of Lenox and Stockbridge, it has a beautiful location in the heart of one of the loveliest villages in the country.

W. A. WHITTLESEY'S HOUSE, PITTSFIELD, MASS.

Probably there is no more encouraging sign, in these times of advancement and prosperity, than the desire for information upon, and understanding of, the arts and sciences, and the study devoted to them. Many people are to-day interested in, and laboring for the institutions that help toward better things. In the United States, museums, libraries, and galleries are slowly but continually growing, and the advancement is just as surely being developed to the welfare of all. The results of this great movement are seen on all sides, and what is more natural and logical than that those so active and instrumental in creating and in maintaining these beautiful influences should themselves dwell in houses that are examples of cultivation and refinement? When one reads the criticisms on public and commercial, and on ecclesiastical, designs and results, and recognizes their justice and force, the task of writing upon domestic architecture becomes a difficult and hazardous one. For, if a home expressing the sentiment, taste, and refinement of its inmates be not beyond the intrusion of the critic and scoffer, where may we look for seclusion, freedom, and relaxation? The difficulties surrounding the designer of a country house are so numerous and insinuating, and so hard to overcome, that many good things are harmed, and the best intentions diverted through sheer discouragement. A design in harmony with the surroundings, and in some degree adapted to the needs and requirements of the occupants, is submitted to the criticism of friends and relatives, "who have had great experience in building," and then the mischief begins to develop. Their suggestions, made in all sincerity and honesty, yet without understanding the situation or object of the design, frequently destroy the scheme of the architect, and the whole is ruined from his point of view, and the spirit departeth from the house. When the architect receives the degree of confidence and reliance shown the legal or the medical adviser, "then shall his sins be upon him." But, so long as "*we* made the plans ourselves, and only got Mr. Blank to draw them out," then should their sins be upon them. One of the first inquiries made when a client explains his wants is: What style or character of a house do you wish? Colonial is popular and frequently desired, and naturally the question arises; What is Colonial? Is it an effort to repeat from memory and without skilled or professional assistance the Continental or Adams Brothers style, as so many examples in the southern States, and the old manor houses of the northern, would indicate, or is it the low-hipped and gabled style of New England, so attractive in its simplicity and quiet? And here is an opportunity to say a few words upon this problem of the owner's right to build as seemeth best to him and for his own pleasure and comfort, rather than to satisfy the critic or tourist who chances that

way. Whom should the architect and landscape-gardener first consider? Whom please? and why? Will someone more enlightened give the answer, and thus relieve the minds of many now laboring under the weight of uncertainty and doubt? Another not unusual experience is that the needs and requirements of a family change frequently and radically, and what was at one time the ideal for comfort, convenience, and utility becomes insufficient for the needs of the household. This may lead to disappointment and to criticism; but who may see and provide against such emergencies?

Some difficulties are encountered in Berkshire that are not met with in the southern or coast climates, and, after experience, the architect learns to discard many of the features that are so attractive in less severe regions. The middle south, about the vicinity of Cincinnati and St. Louis and similarly-situated cities, for instance, permits of treatment that is entirely unsatisfactory in Berkshire, and still greater liberty may be indulged in the cities of Savannah and Charleston, and locations corresponding to them in environment and climate.

The north-west, on the other hand,—Minneapolis and St. Paul being typical examples, — is more like Berkshire than any other section in its climatic conditions. The severe cold, and the curious and damaging results produced by the formation of ice on the shady portions of the roof while the snow melts on its sunny slopes, have taught house-owners and architects many lessons that are not readily forgotten. Yet who, having lived in Berkshire long enough to enjoy her people and her hospitality, has been quite satisfied to leave it? It seems a country so full of beauty, strength, and nobility in her landscape that one wonders how any one can live in it and not be generous, strong and true. Nowhere can be seen so many exponents of different styles of architecture, and some, no doubt, deserve severe architectural criticism. But, thanks to the wondrous hills and forests, every outline softens into an effect that gratifies the eye, even while it may sometimes offend the taste of the witness of truth in art. Truly, Berkshire, with her inspiration to elevate the standard of the homes of America, need not be ashamed of the results thus far accomplished, and happy is the man called by his profession to add his conception of truth and beauty to its charm, and happier still he who may own, be it a castle or cottage, a home in Berkshire.

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* The Homestead was originally built for Miss Julia Appleton, from drawings by McKim, Mead and White. The front and hall are from their designs. Mr. Wilson added the ball room for Mr. Stokes. The Cook house is by Peabody & Stearns, of Boston; the Laflin and H. W. Bishop houses by Henry Ives Cobb, of Chicago; the Sampson house by Fuller & Wheeler, of Albany; the Procter House by Mr. Stickney of Providence, R. I.; the other houses illustrated are from Mr. Wilson's own designs.

THE PRINCIPLES AND DEVELOPMENT OF THE ROTARY ENGINE.

By Elmer S. Farwell.

INTEREST has revived recently in the war periodically waged against that piece of primitive mechanism, suggestive of barbaric ignorance, the reciprocating engine of Watt. Occasionally an article appears which recites the extravagant use of energy of the present steam engine, and gives assurance that, with some forthcoming invention, the largest ocean greyhound can be run across the Atlantic with the energy contained in a pint of water, provided no one on board is skeptical or out of sympathy with the new motor. Such a statement is at once recognized as an old acquaintance. It is also tame news that the steam engine is to be supplanted by the electric motor deriving its energy from some unknown source.

The latest canard, however, at least is garbed in new attire. It emanates from a little town bearing the significant title of Sleepyeye, and is to the effect that the old steam engine has been completely routed. It is to be immediately forced into oblivion by a startling new invention in the shape of a steam engine which revolves, and which, Minerva-like, has sprung into full and complete existence from the head of an inventive Jupiter. For this rotary engine the "English Syndicate" so dear to the hearts of a section of the American public is said to have paid the usual fabulous price.

It is not in the province of this article to discuss whether or not the rotary engine ever will supersede the ordinary reciprocating engine, either in whole or in part. But it may not be unprofitable to glance at the attempts heretofore made to accomplish this.

Retrace the paths of progress through the dark ages almost to the dawn of history, and there an account of a rotary steam engine will be found. It is, in fact, the first attempt to utilize steam of which any account exists, either in history or in tradition. Known to the earlier ages of Egyptian science and to the later ages of Grecian refinement, this engine appears to have played its part in adding to the elegance of oriental luxury and to the mystification of idol-worshippers.

It is possible that, had not the magnificent Alexandrian library been destroyed by the Mussulman zealots, other records of a similar nature would now exist. Both Pliny and Vitruvius mention Ktesibios as famous for his skill in the invention of pneumatic and hydraulic in-

struments, and refer to the Commentaries of Ktesibios himself. These Commentaries are lost, but Hero, a pupil of Ktesibios, in a work on pneumatics,* published about B. C. 150, has preserved many inventions of those who at that time were "ancient philosophers and mechanicians." He says in his introduction: "We have thought proper to arrange in order what has been handed down by former writers, and to add thereto our own discoveries,—a task from which much advantage will result to those who shall hereafter devote themselves to the study of mathematics."

The fiftieth proposition of this remarkable work presents the embryonic steam engine. A closed boiler supports above it a hollow ball, which communicates with the boiler through a hollow support. Attached to this ball are two bent tubes, through which steam issues, causing the ball to revolve in the opposite direction by its reactive force. The uses of this engine were various, and its possibilities great. No one can guess at this late day what hazy visions floated over the mind of this ancient engineer, as he "arranged in order" this beginning of the greatest civilizing art. It contains the germ which, had it been industriously nurtured, would have developed into a nineteenth-century motor. But its inventor was about two thousand years in advance of his times. The Alexandrian engineers were content to raise water by hand, and drag their immense burdens over the sands with thousands of slaves.

Following this, there was practically nothing done toward utilizing the energy of steam for sixteen centuries. In the awakening after the dark ages attention was directed anew to the subject, and a few attempts were made to solve the problem.

One of the earliest of these attempts was that of the Italian engineer, Giovanni Branca, in 1629. In his engine a jet of steam impinged upon the vanes of a horizontal wheel, communicating through a series of toothed wheels with a shaft, from which power was to be taken for many useful purposes. This also was soon forgotten.

From this time on the application of steam to the production of rotary motion seems to have been entirely neglected. All attention and interest were now absorbed in the practical problem of raising water. So important to the Britons had this problem become that all others were obscured. Their mines were being flooded, and would have to be abandoned unless the problem should be soon solved economically. The natural product of this condition was the reciprocating engine of Newcomen. This is the engine which Watt found and applied to the rotation of a shaft. Great as was this step, and great as has been the resulting progress, it does not necessarily follow that

* "Pneumatics" of Hero, translated by Woodcroft: London, Taylor, Walten & Moberly.

it was the only, or even the best, solution of the problem. If an engine could be devised which would economically produce rotation direct without the intervention of the complicated mechanism of the ordinary engine, it would certainly be a great advance. Watt recognized this, and set out to accomplish it. In his first patent, granted in 1769, he suggested a "rotatory" engine in which the steam vessels or cylinders are in the form of hollow rings, or circular channels, and are attached to the shaft which they rotate. Later, he actually constructed a "rotative" engine, for which he received a patent in 1782. But even in this engine the dominant idea of a piston and reciprocating part is retained. Rigidly attached to the shaft is a piston which moves in a cylindrical vessel. An abutment is hinged to the outer part of the casement, to allow the piston to pass and rotate continuously in one direction. Some modifications in detail were suggested. After many attempts and failures, he wrote: "they have their respective merits; but instead of being more simple in their construction, they are more complex than those derived from reciprocating motions, and more difficult in execution." These conclusions have since been verified by a great many inventors of this type of engine.

In these first three rotary engines are illustrated the three general types,—the reaction engine of Hero, the impulse engine of Branca, and the piston, or pressure, engine of Watt. Each of these pioneer inventors has had many followers, as the records of the patent office will show. Most, but not all, of these engines have existed only on paper, or in the fertile imagination of the inventor. In some instances the engine has been built, and proved the first and the last of its species.

A glance at an ordinary engine, with its piston, crosshead, wrist pin, crank pin, eccentric, and distributing valves, all consuming power, and with its massive frame to withstand shocks, heavy fly-wheel, and costly foundation, shows at once that it is not an ideal motor. The idea of a rotary engine dispensing with all these complications at once presents itself. The problem seems so simple, fascinating, and easy of solution as to have induced many to attempt it. But at present the ordinary engine appears to be very much in evidence. The contemplation of a light, simple, compact engine running quietly at a high speed, with no dead center, the pull absolutely uniform, no fly-wheel, and on practically no foundation, is truly an alluring dream.

The lack of originality displayed by the majority of these inventors is very marked. They have done what at first thought seemed so simple,—*i. e.*, attached the piston directly to the crank, and let it rotate in an annular cylinder. They have dispensed with some of the objectionable features of the ordinary engine, but retained and usually

aggravated the worst one. The piston must still be packed and lubricated, so that the same difficulties exist in the use of high-pressure or superheated steam. As the action of the steam is the same as in an ordinary engine, no more of its intrinsic energy can be utilized, and the cylinder is still subjected to alternate heating and cooling. The difficulty of making a rectangular piston to fit the cylinder so tightly as to avoid an extravagant leakage of steam is not easily overcome. If it is made steam-tight, the friction is out of all proportion to the size of the engine, since the piston-speed is so high.

Many engines of this type have been made by eminent engineering firms, but have never been able to compete with the ordinary engine where any consideration is given to the question of steam economy. Some fifty years ago two vessels were fitted with engines of this type, made in accordance with the patents of Peter Borrie. Both boats were lost at sea, and the experiment was never repeated.

Mr. Westinghouse attempted to solve this problem of friction by using for the cylinder a bushing which was free to revolve with the pistons. Steam-packing grooves were employed between the bushing and cylinder. The friction of this bushing on the cylinder was said to be but one-twentieth of what would have been developed with no bushing under a similar condition and velocity of piston.

Fully eighty-five per cent. of the rotary engines heretofore patented have been of the piston type, and not one of them, it is believed, was ever in successful operation.

The reaction engine of Hero is the simplest possible form of steam engine, and, where fuel economy is of little moment, it has been "successfully" employed. Its success apparently lies in the single fact that it runs.

About the year 1833 Mr. Avery built several engines of this type, one of which was used for several years to run the machinery in his shop. Another was employed to drive the printing-presses of the *American Railroad Journal*. The editor of this paper records that "it is indeed so perfect, and the velocity so great, being about five thousand revolutions per minute, that, but for other machinery attached to the engine, a casual observer would scarcely know that a steam engine was in operation." This engine was also applied to a locomotive which ran for some time on the Newark railroad,—"with great success," the enthusiastic editor states. Continuing, he says: "When Mr. Avery shall have completed another and more powerful engine, which he has now in course of construction, we doubt not his attaining a greater velocity than has ever yet been attained in this country or even in Europe. We shall probably be deemed rotary-engine mad when forty miles an hour is named as not difficult of attainment."

"This engine will, we doubt not, perform all we have here predicted; and, if so, what can prevent them from being generally adopted on all our railroads?" But it does not appear to have been very generally adopted. At least a large percentage of the locomotives of to-day still cling to the reciprocating principle. Possibly Mr. Avery was unfortunate in living at a time when the "English Syndicate" was unknown in America. But, "with true Yankee enterprise," he took one of his engines, complete, to England. "If the mountain will not come to Mahomet, Mahomet will go to the mountain." Although this appears to close the history of this interesting engine, it is to be hoped that it did not prove a Jonah, as did that of Peter Borrie.

Recently Mr. Morton has been experimenting on this type of engine. He has adopted a peculiarly-curved and expanding nozzle, and uses two or more discs in series. He obtained fairly good results, but not such as to warrant their general adoption.

In this type of engine many of the objectionable features retained in the rotary-piston engine have been disposed of. There are no moving parts to be packed; consequently there is no friction, except on the shaft. The steam comes in contact with no lubricated surfaces, thus permitting the use of high-pressure superheated steam. There is no oil in the exhaust steam to cause priming in the boiler, and priming, if it should occur, cannot ruin the engine. With a properly-shaped nozzle, an efficient expansion of steam may be had without alternately heating and cooling any surface.

A moment's consideration, however, of the theory of reaction wheels will demonstrate the fallacy of their use. Their efficiency cannot reach unity until the wheel revolves with a peripheral velocity equal to the velocity of efflux of the steam—a practical impossibility. Should the velocities thus become equal, the work which might be performed would become zero. No economical performance, therefore, can be expected from this type of engine.

The impulse engine of Branca alone remains to be considered. Mr. Dow and Mr. Parsons are both building engines of this type. Both engines operate very much on the same principle as the hydraulic turbine. The steam passes through a set of fixed guides, and impinges on moving vanes. After giving up part of its energy here, it passes through another set of guides, and impinges on another set of moving vanes. This is repeated as many times as is desirable, according to the size, power, and speed of the engine. Very good results are said to have been obtained. They have all the advantages of the reaction engines, together with some additional ones. But, as the clearance between the moving vanes and fixed guides is appreciable, it would seem that the leakage must be considerable, and

the steam consumption consequently high. Besides, there is no way of regulating them, except by a throttle governor. Notwithstanding these apparent objections, Mr. Parsons has succeeded in introducing a number of his engines for use in electric-lighting plants. The perfect steadiness of motion of this engine, running at about five thousand revolutions, is said to prolong the life of an incandescent lamp materially.

M. de Laval has attempted to solve the question of leakage of steam by allowing the steam to completely expand in a properly-shaped nozzle, and convert its entire energy into actual energy before striking the revolving blades. As there is but one set of blades, the speed is necessarily from twenty-five to thirty thousand revolutions per minute. Much power is lost in the high-ratio reduction gearing. At this high speed the disc assumes its own center of rotation, which may not, and usually does not, coincide with its geometrical center. A flexible shaft, therefore, has been found necessary. This engine also is governed by throttling. No provision is made in any of these engines to renew the parts worn by the action of steam, and by that of "grit" which comes over with the steam, and a slight deformation of the nozzle or blades reduces the efficiency materially. This engine is meeting with some favor, particularly in France. Authentic tests place the steam consumption low.

Mr. Curtis has recently attempted some improvements on this engine by providing a better regulation, and reducing the speed. He provides means for varying the size of the nozzle, but at the sacrifice of its proper shape. For complete and economical expansion of steam the nozzle should be circular in cross-section and gradually expanding. In order to reduce the speed, he allows the steam to impinge on a series of blades in succession. As the steam is completely expanded in the nozzle, there is not the tendency to leakage that exists where the steam is constantly under pressure. Recent preliminary tests of this engine show that, when operated non-condensing, the steam consumption is about equal to that of a non-condensing high-speed simple reciprocating engine, and, when operated condensing, the steam consumption is about seven per cent. more than that of a compound condensing reciprocating engine.

On the whole, it is safe to say that, whatever the advantages of the ideal rotary engine, and whatever the future may have in store, the days of the reciprocating engine are not at present easily numbered. However, the indications are that the rotary engine has come to stay, and may soon find a place in the arts peculiarly its own. It is interesting to note, also, that the type which now gives the greatest promise of success is the second oldest known.

Review of the Engineering Press

Efficiency of Built-up Wooden Beams.

BOTH to engineers and architects the subject named in the above title is of growing importance, in view of the rapidly-diminishing timber resources of the United States. Already difficulty in obtaining beams of large size is experienced, and resort to built-up beams will become more frequent as time goes on. Prof. Edgar Kidwell, in *Engineering News* (March 11), refers to the meager literature of the subject, consisting for the most part of data supplied by Tredgold and freely copied without question by other writers. The majority of these, in cautioning against the belief that a built-up beam can be made stronger than a solid one of the same timber and dimensions, leave it by implication to be inferred that such beams may be made at least as strong as solid beams,—a conclusion which, Prof. Kidwell affirms, is not warranted by his own practical experience. He has therefore made the strength of built-up beams the subject of experimental tests, and promises to publish later a full report of the data so obtained. In his contribution to *Engineering News* he anticipates this report by a brief summary of results, defining efficiency as "the ratio of strength of a built beam" to the strength "of a solid one of the same size and quality of material." The method of the tests is given as follows: "Best quality clear white pine was used, and each piece was sawed into four equal sticks by one longitudinal, and one middle cut. Of these, two pieces diagonally situated . . . were made up into a compound beam," while the other two "were tested as check pieces." The sum of the breaking loads of the two check pieces was doubled, and to this was added the weight of the two pieces. The result gives four times the average strength of a check piece, which is equivalent to the strength of a solid beam double the depth of the check piece, and of exactly the same quality. The breaking load of the built beam, corrected for weight, was then divided by the quantity just found, and the result was the efficiency. Up to date seventy-four built beams have been tested. Clark's design for built beams is criticised as not based on correct principles, and as lacking both in efficiency and stiffness. The efficiency stated by Clark is also challenged on the ground of an error in reasoning. Keyed or joggled beams are considered superior to any other form. The average efficiency of all the built beams so far tested by Prof. Kidwell is 87.7 per cent., the lowest efficiency being 55.5 per cent., and the highest being 108.5 per cent.,—a solitary instance wherein a figure higher than that of the solid beam is tabulated. Whether this exceptional percentage actually existed, or is a misprint, or is the result of a defective experiment, seems uncertain. It is hardly conceivable that an efficiency greater than that of a solid beam could have actually existed. Many useful hints relating to the building up of beams, and to the movement of the keys and other fastenings due to the yielding of the wood, are presented in Prof. Kidwell's article.

English Homes for Workingmen.

THE above is the title of an illustrated article contributed to *The Inland Architect and News Record* for March, by Octavius Grant Wood. It describes Port Sunlight, a model village for working people, situated less than six miles from the steamship landing at Liverpool. The problem of supplying comfortable sanitary dwellings for working people has had many of its difficulties removed by the introduction and great extension of cheap suburban transportation. The village of Port Sunlight well exemplifies the possibilities in suburban dwellings erected where land is comparatively cheap, though, as the dwellings therein are occupied mainly by workmen employed in a manufacturing industry conducted there, the working out of the solution has not been complicated with

the problem of transportation, as would have been the case had the inhabitants been employed in the adjacent city. No one who peruses Mr. Wood's description will dissent from his view that "this village is worthy of the attention of all students of political economy and social science, as showing by actual practical demonstration how much can be done to bring about happiness and plenty to all employed there." The industry, we are told, has prospered under this liberal policy to the workmen, but some additional information concerning its nature, the wages paid, etc., would have been acceptable, and is desirable. The village is young, having been founded a little over ten years ago. "The streets are laid out after the style of our American cities somewhat, with trees planted in the streets and lawns in front of the houses. It is not modern in the sense of some of our American towns, with electric cars rushing through the streets, and saloons on every corner; there are no aldermen to give away franchises regardless of the will of the people; but the homes of the workmen are modern, and contain the luxuries of bath, hot and cold water, gas, water-closet, etc.,—in fact, all scientific sanitary arrangements. Cosy fireplaces are in nearly every room, and all are neatly decorated." All this is afforded for a monthly rental of from four to six dollars. The rent includes gas and water, and "is scarcely sufficient to keep the houses in repair." It is evident, therefore, that houses of this kind could not be rented at such rates to people not employed in the industry which supports the town, and that the difference between the stated rentals and such rentals as would pay, over and above repairs, a fair interest on the investment must be regarded as part of the wages of those who reside in them. The employer and employed together govern the village. There are some twenty departments in the works, and each elects from one to six members of a "village council," the manager of each department being also a representative therein. The village appears to be remarkable for its clubs and social institutions. In fact, Mr. Wood tells us, "the main work of the council appears to be the management and care of these clubs and social institutions. . . . To be a member of any club or society costs twenty-four cents a year, the firm adding three times this amount for each person joining, and supplying billiard tables, music, musical instruments, band uniforms, etc." Here, therefore, is another item in the wages of the employees. There are public buildings, including a large hall; a pavilion for club meetings; brick school buildings, costing $70,000, finished with English oak, and supplied with school furniture made in the United States; and a church which "dates back to the time of Cromwell, and was only saved from destruction by that great reformer turning it into a stable for cavalry." The schools are free, being maintained by the employing firm (Lever Brothers). Here is still another wage item. The homes of the workingmen are, however, the great feature of interest to architects. Think of the dwelling of the immortal Shakespeare, at Stratford on Avon, having been adopted as a model for workingmen's homes, the interior having been "modernized and arranged for family comfort." This has been done, however, "and the workman returning home after his eight hours' work, to one of these beautiful cottages, all clean and neat, may be just as happy as the prince returning from the chase to his castle. . . . There is a total absence of all signs . . . that the place does not belong to the employee as well as the employer; and whether it is socialism, collectivism, communism, profit-sharing, or simply good, sound business management, the fact is plain to all that prosperity and good wages, short work-day, and all manner of pleasures are to be found in Port Sunlight."

Curious Freak of a Voltaic Arc.

WESTERN ELECTRICIAN (March 27) describes the curious behavior of an electric arc, its cause and its remedy. The arc was used in connection with a hemispherical reflector to illuminate an advertising device, one of the carbons being slightly below, and the other substantially above,

the axis of the reflector. The reflector was set at such a distance from the point of ignition of the lower carbon that, when the upper carbon was ignited, the heat from it was concentrated directly upon the lower carbon. When the latter carbon burned away, which it did so rapidly as to almost extinguish the light in about half an hour from the time of lighting, the lamp adjusted itself to a position that focussed the heat from the reflector upon the upper carbon, which then burned away in about the same time as the lower one did. Considerable annoyance was experienced before the discovery of the cause led to the proper remedy,—the substitution of a parabolic reflector for the hemispherical one. Previous attempts to cure the trouble by changes of voltage and amperage failed to produce the desired effect, because the curious action of the carbons depended upon a cause entirely independent of the current,—the concentration of heat upon the carbons by the hemispherical reflector. The latter cause would probably have suggested itself at once to a tinman of forty years ago; for, when the old tin wall candle-sticks were used with tin reflectors placed so as to improperly focus the heat upon the candle, the candle was sure to melt away till too short to receive the intense heat-reflection at the focus.

Hot-Water Heating without Fuel.

SUCH is the kind of hot-water heating, according to *The Metal Worker* (March 20), in use "in the vicinity of Boise, Idaho, where, in 1891, thermal waters were discovered at a depth of nearly four hundred feet." As the water, when discovered, gushed to a height of about forty feet, it is plain that it has pressure enough to raise it to the top floors of ordinary dwellings, whence it will flow down and out, and, passing through pipes and radiators, will radiate heat precisely as though this water circulated in an ordinary hot-water heating apparatus in which the water is heated artificially. In fact, it is probable that the expression "heating without fuel" is, in this case, strictly accurate, the water being heated by subterranean chemical action, which is analogous to the action of water upon quick lime; though, if we should trace the series of causes back far enough, we probably should find combustion going on somewhere in the line of approach. But, taking the matter as it now stands, there is, in the vicinity of Boise, a store of subterranean hot water which is under pressure enough to spout above the surface when tapped by artesian wells. In any place where subterranean hot water can be procured, at a depth from which it can be economically pumped through the pipe systems of houses, heat can be distributed in this way. It would make substantially no difference whether the hot water was first pumped to the top of a building for this purpose, or pumped into the bottom of a pipe system to be forced up through such a system; but the latter plan would, we think, require less water. This would introduce the hottest water into the lower part of the system, and it would get cooler as it rose to the more easily warmed upper part. Somewhat less water might thus be required, and less pumping would be needed to supply it. The water at Boise is said to have a temperature of 171° F. A company has been formed for piping the streets and supplying this hot water for heating purposes. *The Metal Worker* gives plans of the different floors and basement of a large building piped for heating in this way. It is claimed that, at the rates at which the water will be supplied, heating by this method will cost about fifty per cent. of the expense of heating with coal at five dollars per ton.

Direct Generation of Electricity from Carbon.

IN a lecture delivered by Willard E. Case before the New York Electrical Society on February 24, belief was expressed that tremendous results will be reached in a field of which we have only crossed the boundaries. This field is that of the direct generation of electricity from carbon without the intervention of the dynamo, or its equivalent. A number of thermo-cells were described and experimentally illustrated by Mr. Case in the course of the

lecture. In the most ordinary method of obtaining current electricity, these wasteful processes must be successively performed. First, heat must be generated from fuel and stored up in some expansive material,—say, steam; second, this heat (or, more properly, only a fraction of it) is converted into work,—the most wasteful process of the three; and, finally, the work so performed is converted into current electricity by a dynamo. Doubtless, in any process for directly generating electricity from a chemical reaction between carbon and oxygen or other substance found suitable, there will always be some waste; but in a well-developed process waste would, in all probability, be very much less than the total waste in the three processes named. The carbon-consuming cells of Jablochkoff, Bard, Crumm, Edison, Wright, and Thompson were briefly mentioned, and the cell invented by Mr. C. S. Bradley with the coöperation of Prof. F. B. Crocker was described more at length. This cell consisted of an iron vessel containing fused sodium manganate and carbon. When air was blown through the fused sodium manganate, nascent oxygen was presented to the carbon. These two combining, a current of electricity with an e. m. f. of one volt was obtained. The sodium manganate was formed in the cell itself by heating caustic soda and peroxid of manganese, in the containing vessel of the cell, 2½ inches in diameter and 6 inches deep. The heating was effected by a gas flame. The lecturer asserted that the cell of W. W. Jacques, which has of late been considerably discussed in the technical press, is substantially nothing more than the Bradley-Crocker cell; or, rather, it is something less, since it differs from the former in nothing except the disuse of the peroxid of manganese, employing the fused caustic soda alone. Mr. Case thinks the theory of the action of these cells is very imperfectly understood, basing this view upon the erratic character and action of both of them; and he described some curious variations in their operation under different conditions. Mr. Case exhibited a cell of his own for the direct generation of electricity by the oxidation of carbon without increase of heat above the normal temperature, and gave a good description of the same. "It consists of two electrodes, one of carbon, surrounded by powdered carbon, in a porous cup, and one of platinum, both being immersed in a glass jar about one inch in diameter and six inches in height and containing sulphuric acid." Chlorate of potash being added, peroxid of chlorine is formed, which yields its oxygen to the carbon and sets up an electric current between the electrodes, the e. m. f. being $1\frac{1}{2}$ volts, more or less, according to the conditions. Mr. Case said: "What I wish to impress upon you is this: in this battery . . . carbon is completely oxidized at normal temperature by oxygen which is held in loose combination. So it is done in the human body, and we know that to be a very efficient machine." In conclusion he expressed his entire belief that a cheap means for doing this will ultimately be found.

Education of Railroad Men.

PROBABLY few men could be found better qualified by occupation, training, experience, and observation to speak authoritatively upon this subject than Mr. Walter G. Berg, well and widely known as an able engineer, a capable railroad man, and a very acceptable contributor to technical publications devoted to engineering and railroading. In these reviews we have frequently recorded valuable opinions and suggestions publicly expressed by him. Not the least valuable of these are broad views of the need of special training for railway men, to fit them for a service which, in many of its features, more nearly approaches military service than perhaps any other civil occupation. The present deliverance printed in the proceedings of the New York Railroad Club for January of the present year, he introduced by stating that he had been "interested for a great many years in the question of the proper education of railroad men;" that twenty years ago he "prepared the data for a report on technical education abroad, embodied in one of the United States consular reports, and visited, supplied with suitable government

credentials, the principal technical and trade schools of the continent and, subsequently, of this country." He also directed attention to the fact that he had written and published an outline for a proposed school for railroad men.* He therefore asserted his views, not as crude, immature concepts, but with the positiveness of convictions long ago formed (and subsequently strengthened by personal observation and study) concerning "the conditions existing in the important business of railroading, taken as a science, a profession, and a trade." Mr. Berg's remarks were in the nature of a discussion of a valuable and suggestive paper read before the New York Railway Club on January 21, by Mr. George B. Leighton, which set forth the facts that "in the upper ranks of the service the highest professional skill has to be brought into play;" that "the railway service bears a most marked analogy to a military system;" that "railway managers are unfortunately, as a rule, forced to devote their time and strength to daily routine details, instead of being able to maintain a general oversight, to settle difficult questions, and to prescribe rules and systems to be followed,—the correct work of true generalship,—and that 'the men who decide these problems to-day have trained their minds almost wholly by experience,—a most thorough teacher, but sometimes a costly and slow one.'" Mr. Berg concedes all these facts, and also agrees with Mr. Leighton "that much . . . of the work, and most of the principles that underlie the successful operation of a railway," can be taught in schools adapted to the railway profession; and that it is desirable that the higher class of railroad work should rank as a profession in itself. But he believes that it would be a grave error to provide alone for the training of this higher grade, as seems to be the aim of Mr. Leighton. On the contrary, Mr. Berg is very positive that "the proper solution of the educational railway problem, as a whole, lies in making sharp distinctions, and maintaining strictly the divisions between the educational plans for the various grades of railroad men." He holds that "heterogeneous elements cannot be shaped in the same educational mold, and that combination systems can never meet successfully the educational requirements of all the various classes of railroad employees. In other words, any contemplated educational system should define specifically which grade of railroad men it is primarily intended for, and be strictly arranged accordingly. Then the party who has a shop mechanic in mind could not taunt the advocate of a special collegiate course with the query: 'What good is calculus, theory of government, political economy, and railway law to a shop mechanic?' while, *vice versa*, the other party, having in mind an education preparatory for entrance into the general or professional offices of a railroad, could not retort by asking: 'Why waste years of a boy's life at a lathe?' The much-vaunted and misunderstood manual-work departments of collegiate institutions would then be relegated to their proper sphere,—namely, to serve as a practical illustrative adjunct to the class-room." Therefore, dividing railroad men into three classes,—(*a*) the highly educated class, instructing and leading, (*b*) the middle class, which supervises and carries out details, and (*c*) the lower class, performing the heavy common labor,—Mr. Berg would draw the line of distinction between the high and middle classes as definitely as possible, "keeping the education of the two as separate and individual as possible," as "the first and most important step forward in the solution of the problem." By implication there are other steps to be taken, and Mr. Berg elaborates these and presents a programme for a special railroad trade school, very much too long for reprint in this place, but to which, from its nature, justice could be done only by presenting it entire.

* *Railroad Gazette*. 1887.

Decimal Wire Gage for Wire and Sheet Iron.

THERE is, no doubt, a most decided leaning towards the adoption of the decimal wire gage, on the part of the majority

of American engineers and mechanics. Such being the case, there is little doubt that a decimal gage is to be the gage of the future. An influence that retards the adoption of the system is the effort to substitute the metric unit for the inch. It is impossible to accurately express thousandths of an inch in the metric system. Hence, if the inch is to be a unit retained (we believe a large majority of engineers, mechanics, and manufacturers want it retained), the metric system, if also retained, will compel another scale of sizes, and therefore we shall be working under different systems as at present, with the same attendant inconveniences. At the request of the council of the American Institute of Mining Engineers, Mr. R. W. Raymond presented at the Chicago meeting of that body, in February, an abstract of the report of Mr. Albert Ladd Colby, of South Bethlehem, Pa., which the latter gentleman presented at the meeting of the Association of American Steel Manufacturers at its October meeting in New York. The report credits the American Institute of Mining Engineers with originating the movement for a decimal gage in 1877, a committee appointed to consider the matter having in October of that year reported favorably upon the proposed change. In 1892 the American Society of Mechanical Engineers also received a report favoring the change from a committee appointed to consider the subject. The change has also been favored by the American Master Mechanics' Association, while committees of coöperation were constituted by the Canadian Society of Civil Engineers, the Engineers' Club of Philadelphia, the Civil Engineers' Society of St. Paul, and the Engineers' Club of St. Louis. The report of the committee of the Association of Steel Manufacturers was mainly directed to the consideration of the advisability of the endorsement by the association of the United States standard gage, approved by act of congress, March 3, 1893, and it advocated the exclusion of all other gages now in use. The fact that, while the United States standard was disapproved, a decimal gage of thousandths of an inch was recommended shows very plainly the drift of opinion in the United States. The United States standard was based upon the relation of weight to the thickness of a square foot of iron rolled to a thickness of $\frac{1}{640}$ of an inch. Such a sheet of iron would weigh one ounce, estimating a cubic foot to weigh 480 pounds. The absurdity and practical inconvenience of such a basis is set forth in Mr. Colby's report in the following quotation:

"There is no practical value to this association in the simple relationship between the United States gage numbers and the weight in ounces per square foot of the sheet or plate measured: first, because when plates are ordered by weight, customers specify the weight in *pounds* per square foot, and not *ounces* (there is no simple relationship between pounds per square foot and these gage numbers . . .); and, second, because the simple relationship between ounces and gage numbers is only true when the sheet or plate is made of iron." This gage merely adds another to the long list of arbitrary gages with numbers in inverse order to thickness, and, as it is open to severe criticism in other respects for defects from which the decimal gage would be wholly free, the report is decidedly favorable to the latter and adverse to the United States gage.

American Machine-Tools—An English Criticism.

It is, in our opinion, quite possible that there is more truth than poetry in the statement of M. H. Austin, works manager of the Wolseley Sheep-Shearing Mach. Co., Limited, Birmingham, England, made in *American Machinist* (March 25). He says he has charge of about fifty thousand dollars' worth of American machine-tools, and that the term "manufacturing" rather than "building," as these terms are used in England, is most applicable to the production of the American tools sent to England, judged by the samples he has charge of. As we have said, this may be the truth. Fifty thousand dollars' worth of machine-tools is not a large fraction of the entire American output. It would not be considered even a large order by many

of our machine-tool builders. If the purchaser of these tools desired to obtain them at the lowest possible price, he could easily have got such tools as are complained of. Builders of inferior tools are to be found in America; possibly some could also be found in England. It is, we submit, hardly fair to judge the entire output of American tools from the small fraction named, unless it can also be shown that they were selected from the tools of representative American builders. We are the more inclined to the belief that the machines complained of are not the product of our best establishments from the statement of the defects made by this English critic. The drills are stated to have their bases and, in some cases, their tables out of square with their spindles, and to have "too light, unsupported columns." True, he says further on that among these tools there are American lathes, "*some of all the best makes*," not one of which bores a parallel hole; but here we do not know what or who the critic has in mind when he says best makes. If he intends to assert that no lathes are made in the United States that will bore a parallel hole, or that have their spindles in line with their beds, within the limits of accuracy possible to the most accomplished English mechanics, he knows little or nothing of the "best makes" of American machine-tools. The rule laid *down* by this critic with reference to testing machine-tools before they are sent out from the works for sale is a good one. He is correct in saying that "no system of manufacture, however elaborate, is of any use without this precaution, at least," if complete satisfaction is aimed at.

Refined Measuring of Bridge Strains.

THE record of the progress of science is more an account of improvement in and performance of refined and accurate measurement than anything else. In proportion as mankind has learned how to measure and weigh, not merely the grossness of matter, but the thrusts, stresses, attractions, and repulsions of invisible forces, has the human race acquired a broader and more complete mastery of the potentialities of nature. Chemistry was nothing, till the balance became its most important aid. Astronomy is, *par excellence*, a science of refined measurement. Civil engineering is based wholly upon data obtained experimentally, upon formulæ derived from the mathematical analysis of such data, and upon refined measurement in surveying, triangulating, levelling, and grading. *Scientific American Supplement* (March 20) notes a number of instruments whereby very delicate determinations can be made,—among them a new instrument which measures so accurately a small fraction of the total strain, say, of a structure like the great suspension bridge connecting New York and Brooklyn, that the increase of strain due to the step of a foot-passenger on that great mass of metal would, it is claimed, be instantly and correctly indicated by it when used with proper precautions against certain errors to which it is liable in the hands of an unskilled manipulator. The instrument embodies a principle which has been much used in delicate measurements—to wit, the change of the direction of a reflected beam of light by a slight change in the position of a small mirror. The reflecting galvanometer of Lord Kelvin, according to Prof. Sylvanus P. Thompson, is capable of indicating to an audience of a thousand persons an electric current of one fifty-four-thousand-millionth part of one ampere, when a lime light is employed. The new instrument, designed to test the expansion and stretching of metals under heat or strain, is described as being very simple. "Its chief part consists of a couple of little mirrors carried on spindles, which, in turn, are fastened to a couple of knife-edges, so that the slightest change in the position of the knife-edge causes a deflection of the mirrors. For the rest there is an ordinary reading telescope, to which is attached a finely-graduated scale, reading down to a hundred-thousandth of an inch. These readings cannot, of course, be detected with the naked eye, but only through a strong telescope. Now, when the knife-edges are lightly clamped against the object to be tested, say, a bar of steel, and the latter be stretched or

expanded, the knife-edges will change position, the mirrors will be deflected, and, as the latter is looked at through the telescope from a distance of five or ten feet, the graduated scale which the mirror reflects seems to move up or down." Of course, the amplitude of this apparent movement supplies the needed datum for calculating the extent of the stretching or expansion. This being the case, great care must be taken to prevent the vitiation of tests by even very minute variations in temperature. On account of its sensitiveness to temperature, it seems hardly possible that, as our contemporary seems to intimate, the instrument could ever be of service in out-of-door determinations of variations of strains in bridge structures and the like, however much it may be adapted to refined researches in the laboratory.

Resistance of Ships at Deep and Shallow Draft.

THE literature of this subject is probably more extensive than that of any other connected with marine engineering. Mr. Joseph R. Oldham, in a paper read before the Civil Engineers' Club of Cleveland (*Journal of the Association of Engineering Societies* for February), says that it would be "a formidable task to merely enumerate the names of eminent mathematicians and experimentalists who have endeavored to discover the laws of the resistance which water offers to the progress of ships, and still more formidable would be any attempt to describe the various theories that have been devised. Again and again has the form of least resistance been announced, but none of these has largely influenced the practical work of designing ships, nor can any be regarded as on a thoroughly scientific basis. In fact, a century and a half of almost continuous inquiry has firmly established the conviction that the problem is one that pure theory can never be expected to solve. The experimental tank for ascertaining the resistance of the wave-making qualities of ship models has proved the most valuable adjunct of the scientist in confronting the multitude of mistaken theories advanced from time to time in connection with ship resistance." It was once very generally believed that a ship's resistance was principally the result of the inertia of the water, and that skin friction was the lesser factor. Now this belief is reversed; the friction factor is the one most considered, and the element of resistance caused by the inertia is little regarded. The modern view is that the resistance which a ship encounters from the water is that generated by minute eddies against the hull, and that the velocity of these eddies is a function of the velocity of the ship and her model. "At ten knots per hour the eddy resistance is one pound per square foot of augmented surface, and varies generally for other speeds as the square of the velocity. The bow, however, always experiences resisting pressure in proportion to the square of its velocity of motion, and requires horse power as the cube of the velocity to overcome resistance. Mr. Oldham's paper proceeds to a discussion of the effect of draft and depth of water in which a vessel moves upon her speed; he cites experimental data to show that, if the total depth of the water be too small in proportion to the draft of the vessel floating therein, a reduction of speed is a consequence. This is one of the conditions which have retarded success with self-propelling boats in shallow canals. One example is given wherein a difference of speed of half a knot over the same measured mile was found to exist between high and low tide. A proper depth of water is, therefore, an essential for a trustworthy speed trial. This question of the relation between the speed of vessels and draft and total depth, is of great importance in the construction of vessels for navigating shallow lakes, rivers, and canals.

THE BRITISH PRESS

The Mutual Relations of the Architect and the Public.

It is interesting to note the opinions of an accomplished and experienced architect upon so broad a topic. This review is an abstract of a paper dealing with it, read by Mr. W. H. Bidlake before the Royal Institute of British Architects and printed in *The Builder* (Feb. 27). Although there is not an inherent antagonism, but quite the contrary, between the architect and the public, there is not that harmony which is desirable. Each taxpayer and rate-payer is a client where State or municipal buildings are concerned. His interest in the matter will lean toward economical construction. The British public is charged with indifference to architectural matters, and it is to the credit of British architects that, notwithstanding this fact, so much good architectural work is done. In the time of Seti or Rameses the services of the architect were counted among the highest in the State. The architect was held in similar regard in ancient Athens, and in Florence in the days of the Renaissance. Some of the architects of that period achieved immortal fame. While "a certain degree of wealth ungrudgingly spent is necessary before the enthusiasm of a people can express itself in grand architecture," a too "easy commercial prosperity" begets "a content with the uneventful, commonplace present." Under such a condition, instead of longing and idealizing, people seek luxury and social position; but, "when a people is touched in its heart and emotions, especially when it has been emancipated from some yoke and is intoxicated by the spirit of freedom and hope, then there is an outburst of music and song, and exquisite and grand creations of art." To stimulate the architect to do his best work, there must be an architecturally appreciative public, but public appreciation is worthless, if it be not "critical,—founded on knowledge and good taste." As indifference breeds ignorance, the British public, profoundly indifferent to architecture, is charged with being profoundly ignorant of it, and deficient in good taste. This popular lack of taste is responsible for the production of "an ostentatious class of buildings," which, Mr. Bidlake asserts, is vulgarizing whole districts. From the yield to the popular demand for this class of work, it must be inferred either that "there are architects as insensible to modesty and refinement in design" as the public, "or else that they are content to sacrifice whatever principles they may have in order to captivate the popular taste." The architects lack the healthy stimulus of a cultivated public opinion, and this reacts upon the public by placing it at the mercy of the architect. "The tender mercies of the architect may be very cruel. Having revived Greek, medieval, Gothic, or some other more or less unsuitable style, the architect will tell his client what is at present the fashion, and what is the proper thing to have, and the client, with British long-suffering, will pay heavily for being made miserable and uncomfortable until his lease of life runs out." This public ignorance and lack of taste in matters architectural is not to be wondered at, since the study of English architecture is not part of a curriculum. Even in the schools of art throughout the kingdom, while building construction may be taught, "the study of architectural history and design is conspicuous by its absence." The cause being pointed out, the remedy seems sufficiently obvious; but Mr. Bidwell is not content with a mere implication. He discusses this phase of the subject very explicitly. We quote him on one point,—"the public distrust of the architect on financial grounds." "It is often said that, if you go to an architect to build you a house, you never know when the expense will end. The client lays his wants before his architect, and tells him how much he is prepared to spend. Usually the sum is quite inadequate. Of course the architect tells him so? Not at all. He tells him that it will need economy, and implies that the design which he sub-

mits, and which meets his client's approval, can be carried out for the sum named. All goes well until the builder's tenders are opened, and then comes the disillusionment of the client. The lowest tender is half as much again as the sum to be spent. The architect anticipated as much, but he trusted to his power to surmount the difficulty when the time came." This is a common occurrence. But the architect is not without excuse. "How much more confidence would a client have in his architect . . . if the latter told him at once that it would be impossible to erect the building for the sum named?" Not any more. "He would doubt the architect's judgment, and say that Mr. So-and-So had built a house of similar size for less money, and eventually he would consult another architect . . . willing to mislead him." Nevertheless, the straightforward way is, in the long run, the best way. It will in time secure "the rare distinction of being regarded as an architect whose estimate can be trusted, and that means . . . a practice based upon the most solid foundation."

A Proposed Irish-Channel Tunnel.

"A SCHEME second to none in the annals of engineering" is the expression employed by Mr. J. Ferguson Walker, in the *Contemporary Review* for March, to characterize the project of connecting the islands of Great Britain and Ireland by a channel tunnel, affording thus continuous railway communication between London and Dublin. Without pausing to note the political reasons assigned by Mr. Walker for considering this subject at present, we pass to the various schemes for uniting the two islands that have, from time to time, been projected. These include "causeway, bridge, submerged tube, and tunnel." The project of a causeway was brought forward in the sixties by a member of the bar, and obtained some mention in the house of commons at the time. "The Land Junction of Great Britain and Ireland by an Isthmus at the Mull of Cantyre" is the title of a pamphlet written "about fifteen years ago by Mr. J. Charles King." It reached a second edition. The author's estimate of cost was £2,000,000, but other authorities estimated it at £70,-000,000,—a rather noticeable difference of opinion, from which it may probably be inferred that any approximately accurate judgment of the probable cost could not be made by any one. A channel bridge, which would probably cost from thirty to forty millions of pounds (on the assumption that it could be built at all), has been proposed. Mr. Walker asserts that the question of cost is fatal to all these schemes, not excepting the scheme of Ernest A. Le Sueur, who proposed, in 1894 through the medium of the *Popular Science Monthly*, to dam up the waters of the channel, for the purpose, chiefly, of obtaining a motive power that would supply the whole United Kingdom with electricity. Such a dam would also supply the desired support for a railway track, but, as Col. Eschol Sellers would have said, "this is only a side issue" in the scheme. Mr. Walker declares the project of an isthmus between the north of Scotland and the Mull of Cantyre to be entirely worthless for railway purposes, because the present means of communication is quicker than that ever could be; and a further objection to this scheme is that it would probably leave the ports of Glasgow, Liverpool, Belfast, and Dublin high and dry. The submerged tubular bridge proposed by Mr. Maxton about six years ago is, in the opinion of Mr. Walker, the only rival of the tunnel scheme. The cost is estimated at £5,250,000, but he believes the admittedly somewhat greater cost of a tunnel would be more than compensated by the greater safety. The idea of tunnelling the channel was first seriously proposed by Messrs. Maccassey and Scott in 1868. At the time the practicability of the project was considered doubtful, and it was criticised as not having been worked out in sufficient detail. In 1882 the subject was again agitated, and "was publicly advocated on many occasions." Lord Wolseley favored it, believing it to be more desirable than the much-mooted English channel tunnel. In that year, also, letters favoring a tunnel "from Laggan Head to

the Maiden Islands, near Larne, and thence to the coast of Antrim" were published in *The Railway News*. One important reason for favoring this route was that it would avoid the narrow loch in the bottom of the channel, known as Beaufort's Dyke, which is 150 fathoms, and is situated between the coasts of Wigstoneshire and Antrim. Sir Edward Watkin favored the scheme of a tunnel, and even went so far as to employ a staff of surveyors to examine the route corresponding with the shortest sea-passage between the coasts, known as the Portpatrick and Donaghadee route. In 1886 the subject was twice mentioned in the house of commons, but was not favorably received; the project was still discussed, however, in various quarters. In 1888 Mr. Gladstone's speech advocating the proposed English channel tunnel called forth a pamphlet from Hon. F. Lawley favoring an Irish channel tunnel instead. In February, 1892, the subject was again brought up at the annual meeting of the chamber of commerce in Belfast. The scheme "was warmly supported by Sir Wm. Q. Ewart, . . . and during the month of February the Edinburg and Belfast newspapers were deluged with letters on the question." In March of that year Mr. F. W. M'Cullough, civil engineer, published a comparison of the merits and demerits of the different routes proposed, and arrived at the conclusion that the best route would be from Whitehead to Portpatrick. In April of the same year Mr. Maxton brought out his scheme for a channel tube. Messrs. James and John G. Barton, civil engineers, of Dundalk, in connection with Messrs. Hawkshaw & Hayter, a firm of London engineers previously engaged on the Severn tunnel, having made investigations, a public meeting was called by the mayor of Dublin to hear the results in detail. The names signed to the call for this meeting indicated that the movement did not lack influential support. These engineers advocated a new route (The Gobbins in the Island Magee to Portobello), and the practicability of the scheme, with many other propositions and facts relating to sub-aqueous tunnels, was so thoroughly debated that the question of a tunnel was left "in a very different position from what it had occupied before." It was made clear that there are no insuperable obstacles to the execution of the work, should capital back it up with sufficient strength. In 1891 a discussion of the details of the various routes proposed were discussed in the Belfast Natural History and Philosophical Society. The project was urged by the *Spectator*, and in February Sir Roper Letheridge read a paper, entitled "The Proposed Irish Tunnel," before the Society of Arts. It elicited much discussion. The result of all this agitation has been the formation of the opinion held by able engineers and statesmen that such a tunnel is practicable and desirable; and Mr. Walker appears to have been convinced that such a tunnel will ultimately be constructed. With such a connection passengers could take trains to Londonderry or Sligo, and from these points could reach Nova Scotia by steamer in four days. Mr. Walker makes an elaborate attempt to forecast the extent of probable traffic through a tunnel from Whitehead to Portpatrick, and thinks it would pay a 2½ per cent. dividend on the capital required for construction and operation.

Ropeways.

AN abstract of a paper read by Mr. W. Carrington, M. Inst. C. E., at the last meeting of the Federated Institution of Mining Engineers is given in *The Colliery Guardian* (March 19). The paper described the various types of ropeways, discussed their mechanical construction, and pointed out that the selection of a type of ropeway for a particular service should depend upon the character of the country to be traversed, the materials to be transported, the inclines to be surmounted, the quantity to be transported daily, etc. The attempt to make a single type of ropeway answer for any situation and all requirements has, in the author's opinion, brought undeserved discredit on the system of wire-rope transport,—a system which can do thoroughly efficient and satisfactory work, and can compete well with the or-

dinary ground railways of the class found in mines. The practical introduction of wire ropes for the carriage of loads to any notable commercial extent is credited to Charles Hodgson, who erected a ropeway at Bardon Hill quarries, near Leicester, England (date not stated), believed to be the first erected on any system similar to those now in use. Hodgson patented two systems, one an endless wire rope (speed about four miles per hour) on which the loads were supported and with which they moved, and a second wherein the loads were hung upon two fixed ropes and moved by an endless hauling rope, by means of which the motion was given to the carriers. This system has been most largely used on the European continent, while the running-rope system has been most employed in the British colonies. The running-rope system was for years the only system used in the United States, but more recently the fixed-rope system has very successfully competed with it. Mr. Carrington classifies ropeways into five types; (1) the endless running rope (greatly improved in all its details since its first use at Bardon Hill quarries); (2) an endless-rope type of ropeway, with the carriers rigidly attached to the rope; (3) the fixed-rope type,—two ropes,—also much improved since its first invention; (4) the single fixed-rope type, in which one carrier is drawn to and fro by an endless hauling rope; and (5) two fixed ropes with an endless hauling rope, in which one carrier travels on one fixed rope in an opposite direction to that in which another carrier moves on the other fixed rope. Of these each is better adapted to a certain set of conditions than any of the others. The endless mining rope is considered the most suitable for use where the quantity to be carried does not exceed 400 to 500 tons in 10 hours, where inclines do not exceed 1 in 3, where a single load does not exceed 6 cwt., and where no spans exceeding 600 feet are required. The endless rope with fixed carriers is preferable where there are very steep inclines, with sudden and frequent changes of level. The fixed parallel rope type should be used where the quantities to be transported exceed 500 tons per day of ten hours (grouped lines of the first type may be used instead), where the single load exceeds 6 cwt., where inclines exceed 1 in 2 or 3, and where spans exceed 600 to 1,000 feet. The single fixed-rope system is most suitable for the transport of moderate quantities *per diem*, in heavy single loads, over long spans and steep inclines. The use of two fixed ropes with an endless hauling rope which moves the two carriers in opposite directions is more suitable when the quantity to be moved is not enough to justify the use of No. 3, where the single load is heavy, where spans are long, and when simplicity of detail is desirable. It is said to be cheaper in cost and maintenance, and its operation requires fewer men. Loads of two or three tons can thus be carried over very long spans under favoring circumstances.

The Bertrand-Thiel Open-Hearth Process.

THE belief expressed at the close of the article upon this process in our March number is somewhat shaken by the adverse remarks made by open-hearth steel makers in the discussion that followed the reading of Mr. Gilchrist's paper, and by the comments that have appeared in the technical press,—for example, *The Engineer* (London, Feb. 5), which says "the general tone of the discussion, although very sympathetic, was not in the direction of accepting the author's conclusions in their entirety." Most of those who took part in the discussion appeared to think that the rapid working of the charges described by Mr. Gilchrist was due to the large amount of scrap in the charges. Mr. J. H. Darby, of Brymbo, referred to the observations of his brother at Kladno, as indicating that, when thirteen tons of high phosphorus pig was heated with four tons of scrap, the time for working off the charge was about the same as in the ordinary way (about twelve hours). A want of clearness in statement in some points was charged by Mr. J. E. Stead. For instance, he stated that "the paper was not clear as to whether the increased percentage of pig in the charge had increased the absolute yield of steel ingots." He intimated also that "the enticing reaction between

the metalloids and iron ore added, as a means of increasing the yield of steel above that charged as pig iron, was subject to the objection that the productive capacity of the furnace was reduced, owing to the greater length of time required." He regarded "the rapidity of action of the secondary furnace as due rather to the violent agitation produced by the mixing of the two charges than to any extremely high temperature in the metal." The brown smoke emitted from the metal, described by Mr. Gilchrist and regarded by the latter as evidence of a very high temperature, was said by Mr. Stead not to warrant the inference that the heat was "anything like that of the boiling-point of iron." Mr. Ainsworth, another open-hearth steel maker, gave it as his opinion that "this brown smoke was commonly seen in working Siemens furnaces." In short, a general skepticism was apparent, which Mr. Gilchrist did not wholly allay in his replies to the various queries and objections put forward. It is probably wise to reserve judgment upon this process till future developments shall have tested the conclusions reached by Mr. Gilchrist.

Prevention of Fires Due to Leaks from Wires.

THE efficient aid rendered by fire-insurance companies in devising rules for the safe use of electric currents for power and lighting having very much greater strength than those previously employed for telegraphy is fully acknowledged by Mr. Frederick Bathurst, A. I. E. E., in his Fothergill prize essay (*Journal of the Society of Arts*, Mar. 12). In his opinion the introduction and use of electric current for illumination and power purposes would have been seriously retarded, except for this timely assistance. At the same time it is intimated that these rules act now, in some measure, as a bar to progress, as, with the lapse of time, "conditions are arising which prevent their rigid and consistent enforcement." While there is a much greater degree of confidence as to the relative safety of the electric light than formerly existed, there still "lurks ominously in the public mind an undefined presentiment that electricity and electric fittings of all kinds are in some way 'dangerous'—if only as presenting to the lay mind the possibility of an accidental shock." The author states the problem of safe wiring to be identical with the adoption of the best means of insulation,—a remark that will seem rather trite to electrical engineers; but his enumeration of principles and discussion of the conditions under which they have to be applied are good. He finds an analogy to the evolution of safe wiring methods in the earlier history of the introduction of illuminating gas, wherein the use of glass tubes, tinned iron, or copper pipes led finally to the use of iron pipes, through the use at first of old gun-barrels. These having demonstrated that iron piping was the proper thing, the manufacture of iron gas-pipe was begun. The first gas-pipes were heavy and expensive. Not till the year 1825 were iron gas-pipes produced by machinery and approximating the present lightness of such pipes. Electricity, unlike gas, needs a solid, instead of a hollow, conductor. Copper has proved the transmitter, *par excellence*, of electric energy, and it is as universally used for this purpose as iron pipes for conveying gas. To confine the current of energy to the solid copper wire a covering more or less resistant to the passage of the current is placed around the wire. The covering, being continuous, has the form of a tube slipped on over the wire,—another analogy between the conduct of electricity and of gas from one point to another. The electromotive force tends to force electricity out of the prescribed path through the insulating covering, in a manner analogous to the tendency of gas to escape through holes or imperfect joints in piping. In both cases the higher the pressure, the greater is the tendency to escape, and the more will actually flow through any open outlet. Defects in insulation are analogous to openings in gas-pipes. The imperviousness of a gas-pipe depends upon the quality of the metal from which it is made, the quality of the fittings used, and the skill with which the fitting is performed. So, also,

the electrical imperviousness of the insulating covering of a copper wire depends upon the quality of the insulating material, and the skill with which it is applied to the wire. A pipe originally impervious to gas may become pervious by the action of exterior substances brought into contact with it. Similarly, an insulating coating may be made pervious to the electric current. The coating may be destroyed by such contact with a destructive agent, or it may be rendered pervious by contact with a substance—for example, moisture—which, without directly destroying, neutralizes more or less its power to insulate. But, when the current escapes through a porous insulator rendered ineffective by absorbed moisture, it generates heat, and may, by charring, destroy the insulating quality of the material, so that, when subsequently dried, it is no longer a good insulator. Those who wish to follow out these analogies will find abundant material in Mr. Bathurst's essay. We shall here trace them no further. Most leaks begin with small, incipient faults that increase as the leakage goes on. "They are not at first readily detected,—usually only when a sensational notice of the defect is given. This possibility further accentuates the necessity of insisting upon good work and the right conditions to start with. An insulator, to be perfect, should be one that will keep its insulating properties under all conditions of temperature, being non-corrodible, durable, moisture-proof, fire-resisting, and a reliable armoring. This combination of qualities is at present only partially provided in commercial work; and, considering the growing tendency to increase the voltage of supply, this insulation problem represents a strife between the power of penetrating and the power of resisting, with an all too favorable possibility on the side of penetration." The heating effect of a current increasing as the square of the amperage, a short circuit rush at a defective point can easily become so great as to fuse the conductor. Of course any combustible material in contact with, or near too, the point where such heating occurs is liable to ignite, and thus start a fire in a building. The safety fuses used to prevent such accidents have limitations. Some time elapses before such fuses heat to the fusing-point, and they do not give protection against leaks which are less than those required to fuse them. In other words, a fuse of five-ampere capacity will not prevent a four-ampere leak, and a leakage current of two amperes can cause a fire. The insurance companies name the following as sources of danger from electric wires: "(1) inferior materials and workmanship; (2) conductors of inadequate size and conductivity; (3) perishable and inferior insulating materials; (4) dust, dirt, and moisture; (5) undue heating; and (6) neglect of frequent testing and inspection." Mr. Bathurst summarizes the conditions of danger under three headings, which, he claims, include in broader terms all specified by the companies. His categories are: "(*a*) imperfect insulation; (*b*) imperfect conductivity; and (*c*) imperfect workmanship." Seventy per cent. of electrically-caused fires result from defective conductivity and insulation, and the remaining thirty per cent. from imperfect workmanship. Fully one-third of the conductor troubles come from crosses between wires of different systems. The breaking down of insulation under excessive voltage is also a frequent cause of fires.

Increased Use of Glazed Bricks for Building Purposes.

BOTH for exterior and interior work the use of glazed bricks in building is notably on the increase. "They possess," says *The Builder* (London, Feb. 27) "several advantages over plaster and other wall surfaces, but they also have some disadvantages. They are practically impervious to moisture, easily cleaned, and proof against the acids present in the air and rain. On the other hand, some glazed bricks are easily chipped or cracked, and the glaze may soon be stripped by frost." The best glazed bricks made in England are those produced in the vicinity of Leeds and Halifax. The common salt-glazed bricks are far inferior to "the specially-prepared pressed brick, the face of which is dipped into a 'slip' of fine clay before being fired and salted." The common

glazed bricks are glazed by salt thrown into the kiln. These are chiefly used for sewers, manholes, etc., where a clean, impervious surface, costing little, is desired. As a rule, they are not considered suitable for external or internal face-work. "Dipped bricks, known as *best* salt-glazed, are also used in manholes, but more largely in urinals, for dadoes and other internal work, and also for external work, chiefly in plinths . . . ; but occasionally for the whole front of a building. Dipped bricks are first pressed, and, while still green, their faces are dipped into a 'slip' of fine clay carefully weathered and ground, and sifted through fine silk sieves." This clay must be of the same kind as that in the body of the brick, to prevent crazing or shelling off as a result of uneven contraction in the kiln. A good salt-glazed brick is alleged to be almost as smooth as an enamelled brick, and, possessing other desirable qualities is now a formidable rival of the latter. In fact, it has the advantage that its glazing penetrates and is an integral part of the surface, while in the enamelled brick the glazing is a layer of foreign material—porcelain or earthenware—fused fast to the surface. Glazed bricks, besides being of unquestionable durability, are preferable as a material for building, on account of the great variety of color, varying from orange or light red to a deep red brown, which "adds a great charm to finished work." An account of the processes employed in the manufacture of glazed bricks, and of the accidents liable to occur in firing, adds interest to the article.

The Ashcroft Processes for the Electrolytic Treatment of Ores.

WE find in the *Australian Mining Standard* (Jan. 20) an article devoted to a general description of the above processes, which are claimed to be the first to deal successfully with the difficulties of treating electrolytically the sulphid ores on a commercial scale. The processes, having been tested, are about to be put into practical operation at Cockle Creek, near Newcastle, in New South Wales. They are the more interesting on account of their invention by a young electrician, who, though not a metallurgist, discovered the solution of the problem that had hitherto baffled those skilled in the art of extracting metals from ores. It is not claimed that the idea of treating this class of ores electrolytically was new when Mr. Ashcroft essayed its development. "On the contrary, the problem had been often approached, with the result that every inventor had been beaten back with heavy loss, in spite of the many successes which had been from time to time reported." Mr. Ashcroft, having installed an electric lighting station for the Broken Hill Proprietary Company, whose mines had developed enormous masses of zinciferous galena, remained as engineer in charge of the station. That company having called to their aid Dr. Schnabel, an expert metallurgist, to advise as to the best method of treating this ore, Mr. Ashcroft assisted him in preparing a report which was considered very able and exhaustive. This report did little more toward the solution of the problem than to place in a strong light the utter and total inadequacy of the ordinary operations of metallurgy to deal with the difficulties presented by this class of ores. Two conclusions arrived at were that "it would pay to take the ore to the coal, rather than to bring the coal to the ore," and that any successful process must proceed on the lines of leaching out the zinc before the lead and silver were subjected to furnace treatment. Sulphuric or sulphurous acids were indicated as the most promising leaching reagents. Thus the problem came before Mr. Ashcroft, who, besides being "a trained electrical and mechanical engineer, had also a good knowledge of chemical principles." The works at Cockle Creek are designed to treat some two millions of tons of sulphid ores which are already exposed. It is said that this ore averages thirty per cent. of lead, thirty per cent. of zinc, and twenty-five ounces of silver per ton. It is expected to handle five thousand tons of this ore per week, when the installation gets into full operation. The process is cyclic. The ore is first ground fine, and then roasted at a temperature so low that, while the lead and zinc sulphids are converted

into oxids, sulphates, and basic sulphates, the silicates in the ore are not caked. The roasted ore is then leached in shallow vats with ferric chlorid (ten grammes of iron per liter) and an equivalent of sodium sulphate.

The zinc oxid is dissolved as zinc chlorid, while the sodium sulphate prevents solution of the lead; but "some iron and manganese, and a trace of silver, go into solution with the zinc chlorid." When the solution gets a strength of about thirty grams of zinc per liter, the leaching is discontinued. The ferric oxid carried off in considerable quantity in the solution is extracted in the purification process. In this part of the operation the solution is heated by injection of steam, and small quantities of bleaching powder are added, which changes ferrous iron to the ferric state; a small quantity of zinc oxid added brings down the iron. Large agitators are used for this purification. The liquor is filtered, and the cakes of solid matter, rich in silver, left behind are added to the leached ore when it goes to the furnaces for smelting. Silver and traces of other metals are removed in another set of agitators, in which zinc is used as a precipitant. Aluminum and manganese remain in solution, but, as they do not interfere with the electrolytic treatment, it is not sought to remove them. The electrolysis of the purified solution is the next step. The process is so controlled that a bright, hard deposit of pure zinc is obtained, with a current of five amperes and a low electro-motive force, iron anodes being used, which lose one equivalent of iron for every equivalent of zinc deposited. The iron expended is of use in the smelting operations as a flux for the lead. "Chlorid of zinc, however, will not deposit well, if it carries much iron in solution, so that porous diaphragms have to be employed, in order to separate the anolyte from the katholyte." The order in which the electrolysis proceeds is as follows: "The purified chlorid of zinc flows past zinc kathodes of pure rolled zinc. It returns over iron anodes, where it takes into solution the ferrous equivalent of two-thirds of the zinc deposited; finally it passes as anolyte over carbon anodes, where it takes up chlorine equivalent to one-third of the zinc deposited." So far it has been found expedient to exhaust the solution to the extent of twelve grams of zinc per liter of the solution. The solution still containing much zinc is again used for leaching, and so on, over and over. The round of processes thus forms a cycle. The article reviewed presents engravings of the installation at Cockle Creek, and a portrait of the inventor.

THE FRENCH AND GERMAN PRESS

The Society of Civil Engineers of France.

THE completion of the new house for the French Society of Civil Engineers has been the occasion of several articles in the technical journals; the following account is condensed from the *Génie Civil*, the *Construction Moderne*, and the *Schweizerische Bauzeitung*.

The *Société des Ingénieure Civils de France* was organized in the stormy year 1848, with a membership of 134, while now, after fifty years, the membership has reached a total of 2,724, and the society stands as one of the leading professional organizations of Europe. Its monthly transactions, "*Mémoires et Compte-rendu des Travaux de la Société des Ingénieurs Civils de France*," are everywhere recognized as the record of the best typical work of French engineers, and membership in the society is an acknowledged mark of professional eminence.

Those American engineers who had the good fortune to be the guests of the French society during the exposition of 1889 will remember the then quarters in the Cité Rougemont, one of those curious little interior towns encysted, so to speak, in the heart of Paris; even then it was evident that the membership had outgrown the limited accommodations. The new building, recently finished upon ground purchased by the society in the rue Blanche, places the society on a level with the British Institution of Civil Engineers, so far as residence is concerned, and it is a question whether the house in Great George street is not fully equalled by the building in the rue Blanche.

The ground floor of the building contains a large entrance-vestibule, coat-room, lavatories, conversation- and smoking-room, and large meeting-hall. The last-named room, 72 by 49 feet, including the communicating conversation-room, is especially interesting because of the peculiar construction of the floor, whereby it may be mechanically lowered at the platform end and thus in a few minutes be converted into a sloping hall for meetings, or as readily made level when it is to be used for receptions, etc. This hall, being in the rear, is but one story high, with great arched ceiling 10 meters high, and ample skylight illumination.

On the upper floors are committee rooms, offices, etc., the second floor containing ample room for the valuable library, while on the third floor is a laboratory and photographic room and the residence of the general secretary, all rooms being lighted by electricity and warmed by hot water.

The building was constructed in the short space of nine months, from designs by Professor Delmas, and the severe architecture of the Louis XIV period is appropriately applied to the principal façade. The dedication ceremonies took place on January 14, President Faure assisting, and the congratulations of American engineers should be heartily extended to their French brothers upon the completion of the work.

The cost of the building alone was $110,000, to which must be added $80,000 for the ground, making a total of $190,000.

German Locomotives.

THE exhibition at Nuremberg last year was the occasion of the display of a number of locomotives showing the latest examples of design by the leading builders of Germany, and some notice of these, together with those shown at Berlin and at Budapest, has already been given in these columns. The issue of the *Zeitschrift des Vereines deutscher Ingenieure* for January 23 and February 13 contains an article devoted especially to the engines exhibited at Nuremberg, with numerous details and a full drawing of the special engine by Krauss, of Munich, as well as illustrations of the other locomotives shown; and the whole forms a very complete display of the latest types of German engines.

The author of the article, Herr Brückmann, enumerates the leading points of advance in the modern locomotives as follows:

(1) The introduction of much larger boilers, constructed for increased pressures; 180 to 200 pounds;

(2) The use of larger driving wheels, and consequent increase in the distance from the rails to the center of the boilers; 83 to 98 inches;

(3) The general introduction of swivel trucks, instead of the former rigid wheel base;

(4) The introduction of quick-acting automatic brakes, not only on the drivers, but also on the truck-wheels.

In addition to these mechanical changes there are the numerous arrangements for compounding, of which the engines at Nuremberg included a variety of types.

The most interesting engine shown was the compound, double-cylindered locomotive of Krauss, above referred to. Two engines of this type have been used by the Bavarian State Railway for a year. Primarily the engine is a two-cylinder compound with a single pair of 73-inch drivers, swivel truck, and single trailing axle.

In addition, however, there is an auxiliary axle between the main driving axle and the forward truck, carrying an independent pair of small drivers, forty inches in diameter, these being operated by a separate pair of cylinders situated directly underneath the main cylinders. The journal boxes of this auxiliary axle are connected by equalizing levers to the system of springs upon which the weight of the engine is supported, and under ordinary conditions the weight is distributed among all the wheels in proportion to their leverage. The auxiliary axle, however, is provided with a steam-pressure cylinder above it, so connected to the boiler that, when steam pressure is admitted above, a greatly-increased pressure is brought upon it; when the pressure is reversed, it may be lifted entirely out of contact with the rails.

This makes it possible to give a concentrated pressure upon the small drivers, which effectually prevents slipping and enables the entire power of the auxiliary engine to be available for starting or ascending steep grades, while upon all other portions of the road the large single drivers operated by the compound engine are alone used. The engine appears rather complicated, but is really not more so than some four-cylinder compounds, and certainly attacks the starting problem in an effective manner.

Krauss also exhibited a four-cylinder tandem engine of the trunk variety, which closely resembles in its cylinder arrangements some of the old horizontal marine compounds long since abandoned. A compound engine by Maffei, of Munich, has the high-pressure cylinders inside, connecting to the forward cranked axle, while the low-pressure cylinders are outside and connect to the two rear axles, all three axles being also coupled.

Another interesting engine was one of the so-called "Mallet" type, built for the Bavarian State Railways by Maffei. This locomotive differed from the ordinary Mallet engine in being compounded, one pair of cylinders being high-pressure and the other low-pressure, and the steam connection between the two swivel wheel bases being made by a peculiar flexible pipe constructed of a number of corrugated diaphragms riveted together.

In these exhibits there is seen the result of efforts to increase the economy by compounding, to increase the speed by higher pressures and better arrangement of parts, and to increase the tractive power by better distribution of weights. While many of the ideas show evidence of a transition state, they are for that very reason the more interesting, and, notwithstanding the different conditions which obtain in this country, there are many points of value to be gathered from the exhibits at Nuremberg.

The Monier System of Construction.

THE so-called Monier system of combined béton and metal construction is the subject of continual discussion in the technical press, especially the proper method of computing the proportion and strength of the relative parts.

Herr S. Rappaport, of St. Gall, contributes a lucid article on this subject to the *Schweizerische Bauzeitung* for February 27, from which we make extracts.

The idea of employing materials of different kinds to form a combination of superior economy or sustaining power is by no means new. It was not long after man conceived the construction of timber framing that it was seen that the use of iron for certain members would be accompanied with advantages, and the same line of reasoning doubtless led to the production of the Monier system. Béton possesses a high degree of resistance to compression, as does iron to tension; if, therefore, we can so arrange the construction that the compressive stresses shall be received by béton and the tensions by iron, good results should certainly be obtained.

In computing the relative proportions of the materials and their disposition, however, something more than their relative resistances must be considered, if the true value of the construction is to be realized. We must consider the relative *elasticity* under the existing conditions rather than the resistance to rupture. This is well seen if we carry the form of construction to an extreme,—such, for instance, as would be found in a beam of granite reinforced by a beam of rubber beneath, the whole supported at the ends and loaded in the center. It is very evident that rubber would add nothing to the strength of the granite, since the granite beam would be broken by a deflection so small that the rubber would not be subjected to any appreciable stretch. As soon, however, as the granite breaks, the entire load comes upon the rubber, which will then assume such a sag as will enable it to sustain the stress, or will break if its strength be exceeded.

In computing the proportions for such combinations, therefore, it is most essential that the various coefficients of elasticity be determined by careful experiments under conditions similar to those which obtain in actual practice. When this is done, the computations may be made with greater approach to accuracy than has heretofore been attempted.

In this connection we may also call attention to a very valuable series of tests upon the strength and elasticity of granite made by Herr C. Bach, and published in the issue of the *Zeitschr. d. Vereines deutscher Ingenieure* for February 27. The tests included resistance to compression, tension, shearing, and torsion, with especial reference to the modulus of elasticity, the results being both tabulated and expressed graphically.

The same article also includes a general discussion of the laws of elasticity, based upon the study of the behavior of various metals, stone, cement, mortar, and béton, with exponential formulas deduced from the experimental tests, for use in determining the extension, under any given case, for the various materials considered.

Automobile Vehicles in Warfare.

In an article discussing the above subject in *La Revue Technique*, for February 25, Colonel Fix examines the requirements and conditions which must be met in order to achieve success.

Since all military vehicles must be both solid and simple, many features which might be otherwise acceptable must be omitted. Roads which in time of peace are good soon become neglected and demoralized in time of war, and a vehicle, like a soldier, should be able to accommodate itself to all inconveniences. Tires of rubber, whether pneumatic or solid, are inadmissible, both because of the greater weight to be carried and because of the rough usage to be endured. Iron tires alone meet the requirements, and, in view of the great torsional strains, the hubs should be larger than they would otherwise need to be, while, in order to clear surface obstacles, the diameter of the wheels should not be less than that now found in field artillery.

Electricity is barred as a motive power, on account of the impracticability of charging accumulators in the field or *en route*, and steam or petroleum motors alone remain, between these steam having the preference, at least for greater powers, since the petroleum motors at present have not proved satisfactory above 10 h. p.

Practically an automobile vehicle for military service must be a carefully-designed steam-traction engine, planned to

haul artillery and supply-trains anywhere where horses can go; the questions of speed and personal comfort, so important in pleasure vehicles, need hardly be considered.

Colonel Fix shows some very interesting figures relating to the cost of horses in military service, and makes out a strong case for the side of the machine, and it is not at all unlikely that the use of machinery in warfare may soon enter the field service as extensively as it has already entered other departments.

Granite Asphalt Paving.

ACCORDING to an article in *Le Génie Moderne* for February 15, Paris is not altogether satisfied with her fine wood pavements, realizing that, although wood, when maintained in perfect condition, is without a superior for driving or walking, it is far from being unobjectionable on hygienic grounds.

Asphalt alone has had ample trial in Paris, and the only objection which it has raised is that of extreme slipperiness; now a new combination called granite-asphalt is proposed.

This is simply a concrete composed of crushed granite and melted asphalt; when used for paving, it is spread upon a foundation bed of béton. The first layer upon the béton is a thin coating of asphalt alone, followed by a thicker layer of crushed granite,—not pebbles,—followed by a grouting of liquid asphalt mingled with finer crushed granite, rolled in as usual.

This pavement is said to possess all the desirable qualities of asphalt, together with a surface which does not become slippery in wet weather, and which is entirely impervious to all deleterious absorption. It has been used for some time in the cavalry barracks of Germany, and the tests made upon it by the Department of *Ponts et Chaussées*, in Paris, have given very satisfactory results.

Slag Cement.

THE extending use of slag as a material for cement, and the varied opinions as to its real value, render the account of the methods used at the large work at Vitry-le-Français, and published in the *Moniteur Industriel* for February 13, of value and interest.

The manufacture of slag cement consists of two distinct operations,—the selection and preparation of the powdered slag, and the incorporation of the lime. All slag is not adapted for the production of good cement, and both its composition and the manner of its preparation are matters of importance. The slag supplied to the above works comes from the blast furnaces at *Pont-à-Mousson*, and is especially satisfactory for cement, on account of the proportion of lime which it contains, and because of its uniform composition. Its average composition is:

Alumina	22
Silica	32
Lime	42
Oxids of iron, magnesia, etc.	4
	100

Black slags—*i. e.*, those containing a large proportion of metallic oxids—are unsuited for the production of good cement. Although the slag should be basic, the silico-aluminate should not contain an excess of lime, as it in that case becomes too fusible, and flows from the furnace before it has attained the proper temperature to develop the best hydraulic properties. It is also desirable that the slag should be suddenly cooled as soon as drawn from the furnace; this is effectively accomplished by directing against it a stream of water under high pressure, which delivers the slag into a basin of masonry, where it is deposited in a fine granular form. The granular material is then thoroughly dried in an oven upon sheet-iron plates at a temperature of about 1,000° F., diminishing gradually to about 300°. It is then finely ground and bolted, the product being a grayish meal, extremely fine and unctuous to the touch, and requiring only to be mixed with the proper proportion of lime to make the marketable cement.

The mixing with lime is effected in steel tumbling barrels, cast-iron balls being placed in the mass to render, by their motion, the mixture more intimate, the mix-

ture being completed in from sixty to eighty minutes. The proportion of lime varies from one-fourth to one-fifth part of the powdered slag by volume, a good hydraulic lime being employed. At Vitry the lime is produced in kilns belonging to the works.

Slag cement has been used very successfully in the manufacture of cement pipes, about one thousand pounds of cement being used to the cubic yard of siliceous sand. The pipes are formed by ramming in sheet-iron molds, and, after three days' drying, immersion in water for twenty-four hours. They are stacked in the yard for three or four months before using.

Electric Cranes.

THE electric traveling crane is distinctly an American invention, but is finding prompt acceptance abroad. Less than two years ago two small single-motor cranes in the new foundry of Gebrueder Sulzer at Winterthur were pointed out as great novelties, but now several such cranes are described and illustrated in an account of the electrical exhibition recently held at Stuttgart. A ten-ton three-motor traveling crane shown at this exhibition is illustrated and described in the *Zeitschrift des Vereines Deutscher Ingenieure* for January 16; while it shows a number of points of merit, it does not include the latest and best points of practice on this side.

The bridge travel is effected by a squaring shaft operated by its own motor, and this motor is properly placed in the middle of the shaft, in order that any torsion may affect both ends of the bridge alike; like the motors for hoisting and for trolley travel, it operates through worm gearing. The hoisting chain is wound over a pocketed sheave instead of around a drum, thus permitting all the defects which wear and stretch have been found to introduce, and there appears to be no method of lowering, except that of reversal of the motor. An automatic strap brake is provided, which assists the worm gearing to hold the load if the current should be interrupted, and the bridge and trolley are built up of wrought-iron sections in the manner now in general use. Under maximum load the speed of hoist is about 4 feet per minute, increasing for lighter loads to about 20 feet. The trolley travel is about 25 feet, and the bridge travel 50 feet, per minute, and the crane operates with a current of 120 volts' pressure.

Electric Steering Machinery.

THE use of electric power on shipboard is being extended to nearly all the functions formerly performed by auxiliary steam engines, and it is to be expected that the steam steering engines will prove no exception. The *Elektrotechnische Zeitschrift* (Feb. 4) gives an illustrated account of Essberger's electric steering gear, showing very clearly its arrangement and operation. The principle upon which this gear operates is that of two continuously-running motors coupled to an epicyclic train of gearing in such a manner that, when both motors run at the same speed, the motion of the final wheel is zero, but for any difference in speed the shaft is operated in one direction or the other. This "over-running," as it may be called, can continue only so long as the lever upon the bridge is moved, as otherwise a resistance interposes to check the overrunning motor, much in the same manner as the action of a steam steering gear is controlled.

Among the advantages of the electric gear, the greatest, of course, is the absence of the necessity of any mechanical connection between the bridge and the motor room; and the motor portion of the apparatus can be placed as near the rudder as convenient, the wires being readily run to the desired point of control.

It is also an improvement to have the motors continuously in motion. The rudder of a ship may require to be moved several thousand times a day, and the constant reversal of the engines forms a great part of the wear and tear upon a steam steering gear. Essberger's apparatus is now being introduced and tested in the German navy, and similar devices doubtless will be tried soon in the merchant marine.

The Liquefaction of Gases.

THE recent experiments of Professor C. Linde, of Munich, upon the simplification of apparatus for liquefying those gases which have a very low critical point have attracted considerable attention, and a description and illustration of his apparatus is given in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for February 12.

As is well known, there is for every material a so-called critical temperature above which a gas cannot be liquefied, no matter how great the pressure exerted upon it, the gaseous form being retained for the smallest volume into which it can be compressed. In order, therefore, that a gas may be liquefied by pressure, it is necessary that it be maintained at a temperature below the critical point. For the following gases the critical temperatures are: water, 362° C.; bisulphid of carbon, 275° C.; alcohol, 259° C.; ether, 196° C.; carbonic acid, 31° C.; oxygen, — 118° C.; carbonic oxid, —140° C.; nitrogen, —145° C.

To liquefy atmospheric air, therefore, it is necessary that the temperature be reduced to the critical point of nitrogen,—*i. e.*, below —145° C. The usual method of reaching this very low temperature is first to liquefy by pressure some gas which has a critical point readily attained, and then, by permitting this liquid to evaporate at a lower pressure, to produce a much lower temperature, under the influence of which a second gas may be liquefied. By thus proceeding in several stages, the very low critical points may be reached, and it was by this method that Cailletet and Pictet succeeded in bringing oxygen, nitrogen, and even hydrogen to the liquid state.

Prof. Linde, however, has succeeded in dispensing altogether with the auxiliary apparatus for lowering the temperature, and uses instead the expansion of a portion of the already compressed gas which it is desired to liquefy. Briefly, the principal portion of the apparatus consists of a pair of concentric tubes, the compressed gas being allowed partly to expand as it enters the inner one and then returned to the compressor through the annular space between the tubes, where it is cooled by the absorption of heat by the expanding gas. The heat generated by the compression is removed by a separate cooler, and the operation may be continued indefinitely, or until the critical point of the gas is reached, when it is delivered in the liquid form in a collecting vessel.

With this apparatus air has been liquefied by compressing it to about 900 pounds per square inch, and subsequently expanding it to 300 pounds, in continuous cycle, the temperature being lowered by the expansion until the latter pressure was sufficient to produce the liquefaction. The liquid air, when drawn off in a glass beaker, well protected against access of heat, appeared as a pale bluish liquid, slightly milky from particles of solidified carbonic acid. Since nitrogen has a lower boiling-point than oxygen, the former at once began to evaporate, and the remaining liquid thus became constantly richer in oxygen, the temperature rising in half an hour from —189.1° to —184.8° C.

An interesting deduction in this connection is that of the reduction of electrical resistance for low temperatures. According to Holborn & Wien, who have determined the electrical resistance of platinum at 0° C., at the temperature of liquid carbonic acid, and at the temperature of liquid air, the relation of the temperature to the resistance may be expressed by the equation:

$$t = -258.3 + 5.0567 R + 0.005855 R^2.$$

If this relation continues to hold good for temperatures below that of liquid air, it follows from the formula that at a temperature of —258.3 C. the resistance of platinum would become zero.

The Dusseldorf Bridge.

A NUMBER of long-span bridges have lately been constructed and projected in Germany; among those projected the Düsseldorf bridge possesses several points of interest. From an article by Herr R. Krohn in the issue of the *Zeitschr. des Ver. deutscher Ingenieure* for February 13 the following facts are obtained:

Düsseldorf is situated at a sharp bend in the Rhine, on the outer side of the bend; on the opposite side of the Rhine the low-lying land is protected against

floods by a dike. The present means of communication between the two banks is a floating pontoon bridge. The construction of a permanent bridge at Düsseldorf has been frequently discussed, but, as this always involved the improvement of the left bank of the stream, the expense has heretofore been too great an obstacle.

Moreover, the city authorities have always maintained that a bridge would be of small benefit to the municipality, holding that the improvement would be mainly in the value of property on the opposite bank. Taking advantage of this short-sighted policy, a company of capitalists has obtained a concession by which the company secures a large slice of the land, now frequently under water, but lying directly opposite the city, and also the right to build a bridge, the State undertaking the regulation of the river so far as to build a new dike about one thousand feet further out, dredging the material beyond and filling it in behind the embankment. The company also owns the right for a tramway to Crefeld, about ten miles away.

In this way the city will get a fine new bridge at small cost, while the company expects to be fully repaid by the advanced value of the reclaimed land, which, will be placed within a few minutes of the heart of Düsseldorf. The company also takes all the tolls on the bridge, and runs its tramway across to the city.

The design for the bridge is excellent, and consists of two great steel arches, each with a span of 594 feet, the roadway being suspended at the level of the springing of the arches. Three smaller spans on the left bank, and one on the right, complete the bridge, making a total length of more than two thousand feet. The plans were made by the Gutehoffnungshütte, by which company the ironwork will be executed, and one of the conditions of the concession is the maintenance of an uninterrupted waterway of 160 feet in width during the entire period of construction. The construction of the piers was begun last summer, and the bridge is expected to be opened for travel by the close of 1898.

Acetylene.

THE interest in the development of acetylene as an illuminating agent seems to be rather on the increase abroad, possibly owing to judicious commercial demonstrations; and, apart from the strict police regulations enforced in Berlin since the fatal explosion of liquefied acetylene there, its progress has been marked.

An exhibition of a generator was given before a committee of the Austrian Society of Engineers by the company which has the development of the new illuminant in Vienna, and a report of the meeting, which took place on February 9, is given in full in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for February 26.

According to Professor Lippmann, the first definite isolation of acetylene was that of Berthelot in 1859, who produced it by decomposing various organic compounds, such as alcohol, ether, etc., by the electric spark or in red-hot tubes, and also synthetically by surrounding the electric arc between carbon points with hydrogen.

The apparatus shown in Vienna was practically the same as the well-known generator for sulphuretted hydrogen, used in every laboratory, except that the sulphid of iron is replaced by calcium carbid and the sulphuric acid by water. The carbid being placed in a tight vessel submerged in a tank of water, the water is allowed to enter through a small pipe rising from the bottom nearly to the top of the generator. As the acetylene is generated, its pressure increases until further entrance of water is stopped, when the generation of gas ceases; when the pressure is reduced by drawing off the gas, the water again enters.

Especial emphasis was laid by Prof. Lippmann upon the fact that disastrous explosions were due only to the careless use of the liquefied gas. The explosion at Pictet's laboratory in Paris was due to the compression in a vice of a cylinder of the gas under the impression that it was empty, while the disastrous explosion at Isaac's workshop in Berlin was caused by the heating of a steel cylinder full of the liquefied gas,—an event which would have occurred with any gas.

A New Copper Alloy.

A NEW competitor in the field of materials of construction has appeared in the form of the so-called Durana metal, an alloy of copper which has certainly shown most remarkable properties, according to the account given by Professor Dr. Dürre in the *Schweizerische Bauzeitung* for March 6. Durana metal is an alloy of copper made by the firm of Hupertz & Harkort, of Duren, in Rhenish Prussia, and the peculiar properties which it possesses, as well as the very high tests which it has shown, should make it a most valuable addition to the long line of copper alloys already in use.

According to Dr. Dürre, Durana metal has a melting point not greatly different from that of the ordinary bronzes, so that it can be melted and cast in the ordinary brass furnace, its fluidity enabling excellent castings to be made without difficulty. When carefully heated in a suitable furnace, it may be readily wrought, the temperature being raised to a point between a dark and a cherry red. This malleability enables it to be worked under the hammer and in the rolls, until the redness has entirely disappeared, its behavior under these conditions being that of a very soft wrought iron, showing none of the extraordinary hardness and resistance which appear at ordinary temperatures.

The makers have succeeded in producing four different varieties of Durana metal, which have shown, under many hundreds of tests, the following results :

	Ultimate Strength.	Elastic Limit.	Extension.
Hard alloy	90,000 lbs.	74,000 lbs.	9%
Medium "	72,500 "	60,000 "	12%
Soft "	57,000 "	50,000 "	31%
Very soft "	45,000 "	20,000 "	50%

When to these valuable properties are added so low a specific gravity as 8.3 and a high resistance to oxidation, we see that the new metal has claims to consideration.

Nationality of Travelers.

THE frequency with which the railways are used in the various countries of Europe has been tabulated with somewhat interesting results, according to an item in the *Oesterr. Monantschr. f. d. oeff. Baudienst.* England, with its 38,000,000 inhabitants, leads, with 864,500,000 travelers on its railways every year, or 23 travelers to each inhabitant. Belgium comes next, with 86,500,000 travelers for 6,000,000 people, or 14 to 1. Germany holds the third place, having 483,000,000 travelers to 49,000,000 people,—a ratio of 10 to 1. After which come in the order named: Holland, with 7 to 1; France, 6 to 1; Austria, 4 to 1; Hungary, 3 to 1; and Italy, with only two travelers to each inhabitant. The smallest travel in proportion to the population is found on the Russian railways, where there are 3 inhabitants for every traveler each year.

A New Engineering Review.

THE appearance of Vol. I, No. 1, in any line of publication is not always cause for congratulation, but it requires no dissimuation on our part to extend a hearty wellcome to the new-comer into the field of engineering journalism, the *Revue de Mecanique.*

When a review, devoted to mechanical engineering, bears upon its editorial committee such names as those of MM. Haton de la Goupilliere, Gustave Richard, Hirsch, Raffard, and others of like standing and reputation, its position is established in advance; and this promise is already redeemed by the appearance of contributions by MM. Dwelshauvers-Dery, Boulvin, Sauvage, and Richard.

As indicated in the programme laid out by the committee, the new review is to be devoted to the production of articles upon selected subjects in mechanical engineering, bearing upon original investigations, either theoretical or experimental, and forming complete monographs upon distinct groups of machines of exceptional importance. Most of the contributions take the form of serial articles, so that it is not possible immediately to review in these columns the first instalments, but the substance of the various monographs will be taken up here, as their progress permits, and in the meantime the new journal is welcome and recommended.

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Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26s. London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $.4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.*. $5. Boston.
Atlantic Monthly. *m.* $4. New York.
Australian Mining Standard. *w.* 30s. Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18s. London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23s. 8d. London.
Builder, The. *w.* 26s. London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
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Century Magazine. *m.* $4. New York.
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Colliery Guardian. *w.* 27s. 6d. London.
Compressed Air. *m.* $1. New York.
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Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
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Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19s. 6d. London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21s. 8d. London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6d. London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrotechnisches Zeitschrift. *m.* 18.40 marks. Berlin.
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Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36s. London.

Engineers' Gazette. *m.* 8s. London.
Engineering. *w.* 36s. London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
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Engineering News. *w.* $5. New York.
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Eng. Soc. of the School of Prac. Sci. Toronto.
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Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
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Gas World, The. *w.* 13s. London.
Gesundheits-Ingenieur. *s-m.* 16 marks. München.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
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Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
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Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
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Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
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Le Génie Civil. *w.* 45 fr. Paris.
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Mining and Sci. Press. *w.* $3. San Francisco.
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Mining Journal, The. *w.* £1. 8s. London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
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Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6d. London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

BATH-HOUSE.

Brookline's Model Bath-House. Illustrated detailed description. 2,300 w. Eng Rec—March 6, 1897. No. 11,459. 15 cts.

CHURCH.

The New Church of S. Matthew at Bâle. (Die Neue Protestantische Matthäus Kirche in Basel.) Description and perspective of Gothic church building for 1,200 sitters. 1,000 w. 1 plate. Schweizerische Bauzeitung—March 13, 1897. No. 11,742. 30 cts.

CONGRESSIONAL LIBRARY.

The Building for the Library of Congress. J. K. Orvis. A general account of the leading architectural characteristics, mentioning some of the most striking works of art which it contains. Ill. 11,000 w. Arch & Build—April 3, 1897. No. 12,026. 15 cts.

DOMES.

The Modern Dome. A. D. F. Hamlin. A study of dome design in both ancient and modern buildings; the value and beauty of this feature, with special reference to the dome of the new library of the university. 4,000 w. Sch of Mines Quar—Jan., 1897. No. 11,988. 45 cts.

EXPOSITION of 1900.

The New Palaces of the Champs-Elysées. (Les Nouveaux Palais des Champs-Elysées.) Plate and brief description of the new buildings being erected on the site of the former Palace of the Champs-Elysées. 500 w. and plate. La Revue Technique—March 10, 1897. No. 11,760 30 cts.

FALSE PERSPECTIVE.

Deliberate Deception in Ancient Buildings. G. A. T. Middleton. Comment on the discoveries of Prof. Goodyear and others, relating to curves in ancient buildings intended apparently to give impressions of greater length by intentionally exaggerated perspectives. 1,800 w.. Nineteenth Cent—March, 1897. No. 11,609. 45 cts.

FIRE Station.

Station for a Boston Fire Company. Illustrated description of new building on Warren street. 1,400 w. Eng Rec—March 20, 1897. No. 11,805. 15 cts.

FLOORS.

Origin and History of Hollow Tile Fire-Proof Floor Construction. Peter B. Wight. Part first gives the early history in the United States of the use of I beams, brick arches and other forms of floor construction which finally led to the use of hollow tile. Illustrated. 2,500 w. Br Build—March, 1897. Serial. 1st part. No. 11,940. 30 cts.

FOUNDATIONS.

The Conditions of Uniform Pressure in Foundations. (Ueber die Bedingungen einer gleichförmigen Druckvertheilung in den Fundamenten.) R. F. Mayer. A continuation of Prof. Mayer's interesting and valuable studies of the actual conditions existing in foundations of masonry piers. 2,000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1897. No. 11,728. 30 cts.

The Distribution of Pressure in Irregular Foundations. (Druckvertheilung in gebrochenen Fundamentflächen.) A criticism by Prof. Spitzer, of Mélan's theory, together with a graphical demonstration of a method of determining the distribution of pressure, especially in arch piers. 2,000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 12, 1897. No. 11,723. 30 cts.

Distribution of Pressure in Irregular Foundations. (Druckvertheilung in gebrochenen Fundamentflächen.) A reply by Prof Mélan to the strictures of Prof. Spitzer, with diagram further elucidating the subject. 1,000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 26, 1897. No. 11,733. 30 cts.

FRANCE, Soc. of Civil Engineers.

The New House of the Society of Civil Engineers of France. (Das neue Vereinshaus der "Société des ingenieurs civils de France," in Paris.) Illustrated description of the fine new building of the French Civil Engineers. 1,500 w. Schweizerische Bauzeitung—Feb. 27, 1897. No. 11,738. 30 cts.

MASONRY.

Ancient and Modern Masonry. Brief accounts of various constructions, with illustrations. Ill. 900 w. Ill Car and Build—Feb. 26, 1897. No. 11,511. 30 cts.

MONIER Construction.

Computations for Monier Beams. (Berechnungen der Monier-Träger.) A discussion by Herr Rappaport of the combined béton and metal construction, showing the importance of considering very carefully the relative elasticity of the materials used. 2,500 w. Schweizerische Bauzeitung. Feb. 27, 1897. No. 11,739. 30 cts.

NIJNI-NOVGOROD.

The Nijni-Novgorod Exhibition. Illustrations and brief descriptions of water-tower and buildings constructed on Mr. Schuchof's patent principle; their characteristic feature is the absence of any kind of roof-truss or girder. 600 w. Eng Lond —March 19, 1897. No. 11,916. 30 cts.

ROOFING.

Roofing Tiles and Their Manufacture. C. W. Crawford. The manner of holding the tiles to the roof, their advantages and disadvantages, followed by a discussion which includes the paper of Mr. Bleininger

with the one presented. 7,500 w. Brick—March, 1897. No. 11,474. 15 cts.

STYLE.

Is a National Twentieth Century Style of Architecture Probable? Banister Fletcher. Report of a lecture given at the hall of the Carpenters' Company, London. Thinks design and planning must be a work of gradual development. 1,500 w. Arch Lond—March 19, 1897. No. 11,943. 30 cts.

SUNDAY School.

Sunday School Planning. A. F. Wickson. Points out the requirements of these buildings and gives plans. Read before the Toronto Chapter of Architects. 1,600 w. Can Arch—March, 1897. No. 11,836. 30 cts.

TALL Buildings.

Foundation Construction for Tall Buildings. Charles Sooysmith. Illustrated. Devoted principally to a description of the caisson method. 3,800 w. Eng Mag—April, 1897. No. 12,047. 30 cts.

THEATRES.

On Some American Theatre Designs. Editorial review of book on "The Planning and Construction of American Theatres," by William H. Birkmire, with criticisms of presented designs. 2,200 w. Builder—March 6, 1897. No. 11,640. 30 cts.

WORKMEN'S Houses.

The Vienna Society for Better Dwellings. (Der Verein für Arbeiterhäuser in Wien.) A review of the report of the Vienna society for improvement in workmen's houses, with illustrations of designs, with data as to cost of building and maintenance. 1,500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1897. No. 11,726. 30 cts.

English Homes for Workingmen. Octavius Grant Wood. Illustrated description of the cottages at Port Sunlight and an account of the ideal conditions, demonstrating the possibility of bringing happiness and plenty to the employee and also prosperity to the proprietors. 1,500 w. In Arch—March, 1897. No. 11,655. 45 cts.

HEATING AND VENTILATION.

BOILERS.

Church Heated with Battery of Boilers. Describes the heating arrangements in use at St. Patrick's Church at Utica, N. Y. 1,000 w. Mas St Fit—March, 1897. No. 11,920. 15 cts.

CAPITOL.

Heating and Ventilation of the Pennsylvania State Capitol. Brief description, with engravings. The building has been destroyed by fire. 400 w. Heat and Ven—March 15, 1897. No. 11,821. 15 cts.

CHIMNEY.

A Chimney Trouble and the Cause of It. Frederick Dye. Describes a trouble called "syphonage" by those who know of it, that occurred in an English home. 1,400 w. Heat and Ven—March 15, 1897. No. 11,823. 15 cts.

CONVENTION.

The First Convention of Warming and Ventilating Engineers, Berlin, 1896. (Die I. Versammlung von Heizungs-und Lüftungs-Fachmännern in Berlin, 1896.) Containing a general report of the progress and present state of the art of warming and ventilation in Germany. 3,500 w. Zeitschr d Oesterr. Ing u Arch Ver—March 5, 1897. No. 11,735. 30 cts.

ENGINEERING.

Heating and Ventilating Engineering. Calls attention to the demands made on architects, and the growth of these two allied branches, demanding expert service. Also discusses the commissions paid architects and their need of being increased. 2,200 w. Am Arch—March 20, 1897. No. 11,840. 15 cts.

New Method of Heating and Ventilation. Charles Carroll Gilman read at meeting of Am. Soc. of Civ. Engs. Describes experiments based on the fact that air rarified by heating will cause a circulation in the rooms of a building. 1,100 w. Arch and Build—March 27, 1897. No. 11,895. 15 cts.

HEATING.

Improved Apparatus for Heating and Cooking by Electricity. (Noveaux Appareils de Chauffage et de Cuisine par l'Electricité.) Description of the simple and portable cooking and heating devices for use with electric current, now being made in Paris. 2,000 w. Le Génie Moderne. Feb. 15, 1897. No. 11,747. 45 cts.

Rules for Proportioning Furnace Systems. J. H. Kinealy. A study of the problem. Part first states the things necessary to determine and examines some of them. 1,800 w. Met Work—March 13, 1897. No. 11,562. 15 cts.

HOT WATER.

Hot Water Heating Without Fuel. Describes a system found possible in the vicinity of Boise, Idaho, where thermal waters were discovered at a depth of nearly 400 feet, and the water gushed to a height of 40 feet above the ground. 1,000 w. Met Work—March 20, 1897. No. 11,696. 15 cts.

RADIATORS.

Some Relations Between the Arrangement of Heating Surfaces in Radiators, the Velocity of the Air Passing Over Such Surfaces, and Their Efficiency. H. Eisert. An analysis of the results from tests and a study under stated conditions. 3,800 w. Heat and Ven—March 15, 1897. Serial, 1st part. No. 11,825. 15 cts.

SCHOOL Ventilation.

Ventilation of a Brooklyn (N. Y.) School. Ventilation is effected by forcing the air through the buildings by a

blower and out through a system of vent flues leading to a main ventilating shaft. 1,500 w. Eng Rec—March 20, 1897. No. 11,808. 15 cts.

STEAM Heating.

Defective Steam Heating Plants. W. H. Wakeman calls attention to some defects which cause steam plants used for heating purposes to work in an unsatisfactory manner. 1,400 w. Heat and Ven—March 15, 1897. No. 11,822. 15 cts.

LANDSCAPE GARDENING.

GARDEN.

Garden Design. Editorial comment on a recent article by Inigo Thomas. 1,400 w. Gar and For—March 31, 1897. No. 11,951. 15 cts.

PARKS.

Chicago's Lake Front Parks. An account of the improvements being made, at great expense, along the shore of Lake Michigan. 2,000 w. Harper's Wk—April 3, 1897. No. 11,947. 15 cts.

New York Zoological Park. William T. Hornaday. Brief account, with illustrations, of some of the noted zoological gardens of Europe, with statement of New York's prospect of a fine zoological park, and some particulars relating to the proposed plan. 2,700 w. Harper's Wk—March 20, 1897. No. 11,610. 15 cts.

TREES.

Roadside Trees. Editorial protest against the cutting down of trees in rural roads. 1,100 w. Gar and For—March 24, 1897. No. 11,866. 15 cts.

PLUMBING AND GAS FITTING.

BATH-House.

Plumbing a Public Bath House. Describes the plumbing of a new building in Newark, N. J. Illustrated. 1,700 w. Met Work—March 27, 1897. No. 11,894. 15 cts.

BATHS.

St. Marylebone New Baths and Wash-Houses. Description of the arrangement of the new baths and wash-houses recently opened. 1,800 w. Arch Lond—March 12, 1897. No. 11,815. 30 cts.

DRAINAGE.

Notes on Drainage and Sanitation. From the Building World. Calls attention to points of importance in the construction of drains and the renewing of a drainage system. Illustrated. 1,400 w. Dom Engng—March, 1897. No. 11,801. 30 cts.

The Ventilation of House Drains. Richard Horton. Read before the Inst. of San Engs, England. States the usually accepted theory of ventilation, compares it with the facts and gives a few experiments and their results. 1,400 w. San Rec—March 5, 1897. Serial. 1st part. No. 11,628. 30 cts.

SANITATION.

Progress in Household Sanitation. From the Albany Argus. Reviews recent advancement in sanitary plumbing. 1,100 w. San Plumb—March 15, 1897. No. 11,630. 15 cts.

MISCELLANY.

ARCHITECT.

The Architect and the Public. W. H. Bidlake. Read before the Architectural Assn. of London. Discusses how to bring about a more harmonious working for their mutual help. Followed by discussion. 9,500 w. Builder—Feb. 27, 1897. No. 11,526. 30 cts.

ART.

Art and Architecture. Frederick Baumann. Considers the two questions, Is Architecture a Living Art? and Can Architecture Again Become a Living Art? Historical review of the development, with features of the architecture of different ancient nations, finally answering the first question negatively. The educational requirements and paths leading to the affirmative answer of the second question are discussed. 7,500 w. Stone—March, 1897. No. 11,658. 30 cts.

BEAMS.

See same title under Civil Engineering—Miscellany.

BRICKS.

Glazed Bricks. Discusses the advantages and disadvantages of salt-glazed and enamelled bricks, describes their manufacture and method of testing. 1,500 w. Builder—Feb. 27, 1897. No. 11,525. 30 cts.

CARDIFF.

The Architecture of Our Large Provincial Towns. Cardiff. Historical account and illustrated description of architectural points of interest and of the important buildings. 5,800 w. Builder—March 13, 1897. No. 11,810. 30 cts.

GESSO.

Gesso. Matthew Webb. Read before the Applied Art Section, Society of Arts. Explains the distinction between gesso and stucco and touches also on stucco works, the composition of gesso and treatment. 3,000 w. Arch, Lond—March 5, 1897. Serial. 1st part. No. 11,657. 30 cts.

GRANITE, Tests of.

Experimental Investigations Upon Granite. (Untersuchungen von Granit.) C. Bach. A most valuable series of experiments upon the strength and elasticity of granite, with tabulated and graphical records; also an extension of the principles developed to other materials of construction. 10,000 w. Zeitschr d ver deutscher Ing—Feb. 27, 1897. No. 11,711. 30 cts.

GREECE.

Greek Sculpture and Greek Legend. F. S. Granger. Read before the Architectural Assn. Discusses the sculpture of the Acropolis of Athens; the legend of

Athena, the divine protector of the Athenians, and the architecture. 5,200 w. Arch, Lond—March 12, 1897. No. 11,816. 30 cts.

HERALDRY.

Heraldry in English Mediaeval Architecture. W. H. St. John Hope. Abstract of a paper read before the Roy. Inst. of Brit. Archts. Confined to the period between 1216 and 1547. Followed by brief discussion. 1,600 w. Arch, Lond—March 19, 1897. No. 11,942. 30 cts.

LANDSLIDE.

The Fall of the Gumpendorf Slaughter-House in Vienna. (Der Einsturz in Gumpendorfer Schlachthause in Wien.) Illustrated description of the wrecking of a large building by the slipping of the foundation of a retaining wall. 1,000 w. Zeitschr des Oesterr Ing u Arch Ver—Feb. 26, 1897. No. 11,732. 30 cts.

LIBRARY.

The National Library Notes on a lecture by Mr. Barnard R. Green. Ill. 2,500 w. In Arch—March, 1897. No. 11,656. 45 cts.

NEW YORK.

The Sky-Line of New York, 1881-1897. Montgomery Schuyler. Comments on the changes wrought in the appearance of the city as viewed from the harbor, with illustrations giving the view in 1881 and again in 1897. 1,300 w. Harper's Wk—March 20, 1897. No. 11,611. 15 cts.

PARIS.

Paris the Magnificent. H. H. Ragan. Describes the striking features of the city, giving illustrations of the beautiful architecture and streets. 3,000 w. Chau. April, 1897. No. 11,870. 30 cts.

ROOFING.

Roofing Tiles in the Fatherland. Albert V. Bleininger. Considers the process of the manufacture of these tiles, and their classification according to patterns. 3,500 w. Brick—March, 1897. No. 11,473. 15 cts.

SCHMIDT MONUMENT.

Dedication of the Monument to Friedrich Schmidt in Vienna. (Das Friedrich Schmidt Denkmal in Wien.) An account of the ceremonies of the dedication of the portrait statue of the late eminent architect of Vienna with an excellent illustration. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1897. No. 11,729. 30 cts.

STAINED GLASS.

The Art of Stained Glass. Pauline King. The gradual progress, waning and new life of stained glass; the artists most noted in this work, and its success in this country. 1,800 w. Chau—April, 1897. No. 11,872. 30 cts.

TIMBER.

See same title under Civil Engineering—Miscellany.

TRAINING.

On the Probable Influence of the Technical Education Movement Upon the Architect and His Work. Frank Caws. Read at meeting of the Northern Arch Assn. Short discussion. 5600 w. Jour Roy Inst of Brit Archs—March 4, 1897. No. 11,848. 30 cts.

TRAINING.

The Educational Training of Architects. Leopold Eidlitz. Reviews the past practice in the training of architects and its effects. The influence of the science of mechanics on architecture; the influence of history. Discussion follows. 7,000 w. Jour Roy Inst of Brit Archs—March 4, 1897. No. 11,847. 30 cts.

CIVIL ENGINEERING.

BRIDGES.

BRIDGES.

See Standard Specifications for Metal Bridges, Boston & Maine R. R., under Railroad Affairs. Maintenance of Way and Structures.

BRIDGE Extension.

Extension of Skinner Street Bridge. Description and illustration of work made necessary by the extension of the terminal station of the Great Eastern Railway. 2,000 w. Eng Lond—Feb. 26, 1897. No. 11,515. 30 cts.

CANTILEVER.

The Francis-Joseph Bridge at Budapest. (Die Franz-Josefs-Brücke in Budapest.) Illustrated description of the new steel cantilever bridge over the Danube at Budapest. The main clear span is 674 feet, the side spans 260 feet each. 3,500 w. Zeischr d Oesterr Ing u Arch Ver—Feb. 26, 1897. No. 11,731. 15 cts.

DRAWBRIDGE.

The Hydraulic Rolling Bridge of the Port of Cherbourg. (Pont Rouland Hydraulique du Port de Cherbourg.) This is a bridge spanning the passage between two of the basins of the Cherbourg docks and is arranged to be lifted and drawn back by hydraulic power; span 98 feet. 2,500 w. 1 Plate. La Revue Technique—Feb. 25, 1897. No. 11,751. 30 cts.

DULUTH-Superior.

The Duluth-Superior Bridge. Elevation, plan, cross-section, and general description of an important bridge nearly completed, connecting Rice's Point, Duluth, with Connor's Point, Superior. 800 w. R R Gaz—March 12, 1897. No. 11,552. 15 cts.

FOUNDATIONS.

Foundations for Masonry. Deals principally with the setting out of foundations for bridges and the care necessary.

Ill. 1,400 w. Ill Car & Build—Feb 26, 1897. No. 11.510. 30 cts.

GIRDERS.

Contribution to the Question of the Cross Section of Continuous Plate Girders. (Beitrag zur Frage der Querschnittsermittlung Kontinuilicher Blechbalken. A Meves.) A graphical examination of a method by which the greatest bending moment, and consequent section, may be obtained with little labor for any given conditions. 2,500 w. Zeitschr d ver deutscher Ing—Feb. 6, 1897. No. 11,703. 30 cts.

New Formulas for Finding the Economical Height of Plate Girders. Henry Szlapka. Formulas given are simpler than those generally used and claimed to be theoretically exact within the limits of the assumption. 500 w. Eng Rec—March 27, 1897. No. 11,900. 15 cts.

LONG Span.

Long-Span Bridges for Great Cities. O. F. Nichols. A paper presented at the meeting of the Dept. of Engng. of the Brooklyn Inst. of Arts and Sciences, having special reference to projects for crossing the East River, N. Y. 5,000 w. Eng Rec—March 13, 1897. No. 11,638. 15 cts.

MASONRY.

Masonry for Bridges. C. E. Fowler. Illustrated examples of noted bridges are given with a few suggestions. 800 w. Stone—March, 1897. No. 11,660. 30 cts.

MASONRY Arch.

Brick Arch with Stone Facing at the Entrance to Cornell University Campus, Ithaca, N. Y. Illustrated description of arch built in place of old cast-iron bridge at the entrance to the campus. 900 w. Eng News—March 11, 1897. No. 11,550. 15 cts.

MOMENT Table.

An Improved Moment Table. W. C. Armstrong. A table for computing moments and shears in bridge trusses from concentrated loads, presenting new features aiming to reduce the arithmetical work to the least possible limit consistent with the desired accuracy. 1,200 w. Eng News—March 11, 1897. No. 11,549. 15 cts.

NEW ORLEANS.

The Proposed Mississippi River Bridge at New Orleans. Brief description of design, the special features of which are a span of 1,000 ft. and the character of the foundation material. 700 w. Eng News—April 1. 1897. No. 12,014. 15 cts.

NIAGARA.

New Steel Arch Bridge for Trolley Line Across the Niagara Gorge. Orrin E. Dunlap. Describes bridge in course of construction which will afford the first trolley car connection between the Dominion of Canada and the United States. 700 w. W Elec—April 3, 1897. No. 12,025. 15 cts.

STEEL Arch.

Recent Bridge Competitions. (Neue Brückenwettbewerbe. R. Krohn.) A discussion by the engineer of the Gutehoffnungshütte, of recent designs for steel arch bridges of spans of 400 to 640 feet, including the bridges for Bonn, Bern, and Düsseldorf. 6,000 w. Zeitschr d Ver deutscher Ing—Feb. 13, 1897. No. 11,706. 15 cts.

STRAINS.

Measures the Bridge Strain. An account of an instrument so sensitive as to accurately measure the strain caused by the footfall of a pedestrian crossing Brooklyn Bridge. 1,100 w. Sci Am Sup—March 20, 1897. No. 11,670. 15 cts.

SUSPENSION Bridge.

The Suspension Bridge Over the Ohio River at Rochester, Pa. E. K. Morse. Illustrated description of a bridge with a channel span of 800 ft., with some opinions of the writer on the construction of suspension bridges. 3,000 w. Eng News—April 1, 1897. No. 12,010. 15 cts.

Suspension Bridge Over the Ohio River at East Liverpool, O. Hermann Laub. Illustrated description of bridge for highway and electric railway traffic, of the stiffened suspension type. 1,500 w. Eng News—April 1, 1897. No. 12.012. 15 cts.

CANALS, RIVERS AND HARBORS.

CAISSON.

Movable Pneumatic Caisson for Submarine Rock Excavation. From Revue Technique. Description of an apparatus installed by the Prussian Government, near Bingen, for the removal of the rocks in the river Rhine. 600 w. Eng Rec—March 6, 1897. No. 11,455. 15 cts.

The Caisson at North Pier-Head, Madras Harbor. Robert William Thompson. Description, with illustration, of a difficult piece of work. 2,400 w. Ind & East Eng—Jan. 30, 1897. No. 11,465. 45 cts.

CANAL.

The Dismal Swamp (North Carolina) Canal. Croatan. Letter to the editor calling attention to errors in an article published in this same paper in the issue of March 5. 1,100 w. R R Gaz—March 19, 1897. No. 11,691. 15 cts.

DAM.

See Electrical Engineering—Power, and Civil Engineering—Miscellany.

GREAT LAKES.

Raising the Levels of the Great Lakes. B. H. Muehle. Abstract from the advance proofs of a paper presented to the Michigan Engng. Soc. A study of the effect the construction of deep water channels to the sea will have on the levels of the lakes, with a discussion of projects for artificially raising the lakes. 1,700 w. Eng News—March 18, 1897. No. 11,789. 15 cts.

LOCKS.

Cascade Locks. Edw. K. Bishop. Interesting description of locks on the Columbia River, rivalling those of Sault Ste.

Marie in size, and affecting a territory about double the area of New York State. 2,300 w. Sci Am—March 13, 1897. No. 11,533. 15 cts.

MISSISSIPPI Improvement.
The Problem of Deep Water Navigation Through the Passes from the Mississippi River to the Gulf of Mexico. J. A. Ockerson. An account of the character of the passes and the work done on them, with the questions that must be considered in the selection of a proper site for carrying on successful works of channel improvement. Maps. 4,000 w. Jour Assn of Engng Soc—Feb., 1897. No. 11,891. 30 cts.

NEW YORK.
See New York Harbor, under Marine Engineering—Miscellany.

NICARAGUA Canal.
A Spanish View of the Nicaragua Canal. José Guitiérrez Sobral. States briefly the three proposed routes and the difficulties to be met; then discusses the value of a canal cutting the isthmus, and its importance in a military sense. 3,500 w. N Am Rev—April, 1897. No. 11,977 45 cts.

PROPULSION.
See Propellers and Propulsion under Marine Engineering.

RIVER IMPROVEMENT.
The Correction of the Flon and Its Affluents at Lausanne. (Correction du Flon Lausannois et de ses Affluents.) An illustrated account of the improvements of a mountain torrent which had been a constant source of danger from sudden inundations. Gives a good idea of Swiss hydraulic problems. 4,500 w. La Revue Technique. March 10, 1897. No. 11,756. 30 cts.

IRRIGATION.

IRRIGATION.
A Few Hints to Students of Irrigation Engineering. A. M. Ryon. The work in this field that will be required in the future, and the importance that the irrigation engineer should understand the laws and business side of the undertaking. 2,600 w. Sch of Mines Quar—Jan., 1897. No. 11,992. 45 cts.

WATER Supplies.
Water Supplies in Southern California. J. L. Van Ornum. A consideration of the physical characteristics of this region, with a study from personal investigations made eighteen months ago in the San Gabriel and San Bernardino Valleys. The chief mode of development is by tunnelling, though it contains examples of all important methods. 5,500 w. Jour Assn of Engng Soc—Feb., 1897. No. 11,893. 30 cts.

MISCELLANY.

BEAMS.
The Efficiency of Built-Up Wooden Beams. Edgar Kidwell. Summary of results obtained from a series of tests of such beams. Ill. 1,500 w. Eng News—March 11, 1897. No. 11,546. 15 cts.

CEMENT.
European Portland Cement Industry. Frederick H. Lewis. Notes of travel. Part first refers to the works at Grays, Essex, and the Francis works at Cliffe. 1,600 w. Eng Rec—March 13, 1897. No. 11,637. 15 cts.

Notes on the Use and Testing of Hydraulic Cements. H. P. Boardman. These notes are the result of nearly two years' experience in the cement testing laboratory of the Sanitary District of Chicago. Effects of varying proportions of water, testing, machine mixing, &c., are treated in part 1st. 2,700 w. Wis Eng—Jan., 1897. No. 11,865. 45 cts.

Methods of Cement Testing. Replies to a series of questions sent to civil engineers, chemists and others. 3,400 w. Munic Engng—April, 1897. No. 11,997. 30 cts.

CIVIL Engineers' Society.
Homes of the Engineers. An illustration of the new house of the Institution of Civil Engineers in London, with a reference to the work which is being carried on within its walls, and brief history of the society. 2,500 w. Ir & Coal Trds Rev—March 12, 1897. No. 11,852. 30 cts.

COMPENSATION.
Engineering Compensation. M. S. Parker. Brief statement of facts bearing upon the remuneration of civil engineers, and claiming that they are not compensated as highly as in other professional employments, nor as well in the United States as in England. 2,000 w. Jour Assn of Engng Soc—Feb., 1897. No. 11,-890. 30 cts.

DAM.
The Proposed Steel-Faced Concrete Arch Dam, Ogden, Utah. Bids were called for on three distinct plans, which are illustrated and described. 1,800 w. Eng Rec—March 6, 1897. No. 11,454. 15 cts.

PILE Screwing.
A New Hydraulic Pile-Screwing Plant. Illustrated description. 600 w. Ind Engng—Feb. 27, 1897. No. 11,950. 45 cts.

ROADS.
Recent Legislation on Improved Roads. J. L. Van Ornum. A digest of road legislation in the United States, with editorial comment. 4,500 w. Eng News—March 25, 1897. No. 11,877. 15 cts.

TIMBER Preservation.
The Preservation of Structural Timber. John D. Isaacs. Reprinted from the Thirteenth Report of the State Mineralogist of California. Processes tried and abandoned, with a description of the practically successful processes in use, and those useful under stated conditions. 4,000 w. Eng News—March 11, 1897. No. 11,-548. 15 cts.

TUNNEL.

An Irish Channel Tunnel. J. Ferguson Walker. A collection of the main facts of the history of proposed railway communication between Great Britain and Ireland, with some suggestions as to the practical realization of the scheme. 7,800 w. Contemporary Rev—March, 1897. No. 11,644. 45 cts.

WATERPROOF Cements.

Practical Points About Waterproof Cements. (Praktische Erfahrungen über die Herstellung wasserdichte Kitte.) A discussion, with many practical recipes for cements, glues, luting, &c., &c., which will resist the action of moisture. 2,500 w. Glaser's Annalen—March 1, 1897. No. 11,-720. 45 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

CHINA.

China: Its Resources, Industries and Markets, with Special Reference to British Trade. General discussion of the position of this country in relation to trade, with information relating to products, communication, tariff, labor, resources, &c. 10,800 w. Ir & Coal Trd Rev—Feb. 26, 1897. No. 11,561. 30 cts.

ELECTRIC Machinery.

Foreign Duties on Electric Machinery and Lamps. A statement showing the rates of import duty leviable on dynamo-electric machinery and electric lamps in the principal European countries and India. 1,500 w. Cons Repts—March, 1897. No. 11,873. 45 cts.

EXPORT Trade.

The Significance of Our Expanding Export Trade. Thomas A. Eddy. Showing the dependence of export interests upon international banking facilities, swift and regular shipping facilities, and the adaptation of production to foreign demands. 4,100 w. Eng Mag—April, 1897. No. 12,045. 30 cts.

FAILURES.

The Decreasing Commercial Death Rate. An improvement of 11 per cent. in the number of business failures compared with the first quarter of 1896. 900 w. Bradstreet's—April 5, 1897. No. 12,008. 15 cts.

FOREIGN Trade.

Foreign Trade of Argentina, Uruguay and Brazil. Results of investigations conducted by a commission organized by National Assn. of Manufacturers of the U. S. A. The object is to give practical knowledge of the resources of these countries and to indicate means by which trade between these nations and the United States could be enlarged. Maps. 33,000 w. Circ of Nat Assn of Mfrs—No. 12. No. 12,041. 45 cts.

JAPAN.

Commercial Museum in Japan. The rules and regulations of the Osaka Commercial Museum, the purpose of which is to afford a central place for the exhibition of the productions of native and foreign producers. 3,800 w. Cons Repts—March, 1897. No. 11,875. 45 cts.

NAVIGATION Laws.

Protective Navigation Laws. Remarks on the upbuilding of our merchant marine and the bright outlook for our shipping. 2,000 w. Gunton's Mag—April, 1897. No. 12,004. 30 cts.

TARIFF.

Need of Integrity in Tariff Discussion. Discusses the subject as presented by different journals and from different points of view. 2,500 w. Gunton's Mag—April, 1897. No. 12,003. 30 cts.

New Customs Tariff of Barbados. List of import duties to be levied during the period from Jan. 1, 1892, to Dec. 31, 1897. 1,600 w. Bd of Trd Jour—March, 1897. No. 12,042. 30 cts.

Queensland Customs Tariff. A list of articles exempt from duty on importation into the colony, with the dates from which such exemption takes effect. 3,400 w. Bd of Trd Jour—March, 1897. No. 12,043. 30 cts.

The Dingley Tariff Bill. The metal schedule of the new Tariff bill introduced by the Ways and Means Committee of the United States Congress, with editorial comment. 7,800 w. Ir Age—March 18, 1897. No. 11,680. 15 cts.

Tariff Changes and Customs Regulations. Russia, Netherlands, Netherlands-Curacoa, Netherlands-Dutch Guiana, France, France-Tunis, France-Ivory Coast, Portugal, Portugal-Southeast Africa, Italy, Greece, Turkey, United States, Brazil, Bolivia, St. Lucia, St. Vincent, Victoria, West Australia. 3,700 w. Bd of Trd Jour—March, 1897. No. 12,044. 30 cts.

TRADE.

Pushing Our Trade Abroad. A. F. Tennille. Discusses the methods adopted by American manufacturers and compares them with Germany, and suggests the way to remedy. 1,100 w. Elec—March 31, 1897. No. 11,978. 15 cts.

CURRENCY AND FINANCE.

CURRENCY.

How Not to Reform the Currency. A discussion of ideas of Austin W. Wright, as expressed in an article in "Free Banking, &c.," in Electrical Engineering, Aug. 1896. The writer thinks the situation in the United States requires constructive

legislation, obliging all banks to come under a general banking act. 2,400 w. Gunton's Mag—March, 1897. No. 11,488. 30 cts.

CHINA.

Chinese Finance. A short sketch of the main points of an interesting article by Mr. Consul Jamieson, of Shanghai, bearing on the revenue and expenditure of the empire. 1,800 w. Engng—March 12, 1897. No. 11,830. 30 cts.

CURRENCY.

The First Step in Currency Reform. Henry J. Ford. A discussion of the situation in the United States, urging banking reform before the retirement of treasury notes, and criticism of the resolutions of the Indianapolis Monetary Convention. 1,800 w. Bankers' Mag N Y—March, 1897. No. 11,645. 45 cts.

FINANCE.

Growth of Sound Financial Opinion. Reviews the history of financial opinion in the United States, shows encouraging signs of a general growth of uniform opinion on the essential principles of finance, and gives the suggestions for reform as presented in the N. Y. Journal of Commerce. 3,800 w. Gunton's Mag—March, 1897. No. 11,486. 30 cts.

FINANCIAL Problem.

Arbitration the Only Solution of the Financial Problem. Allen Ripley Foote. Reasons for constituting a United States currency commission are given and the various phases of the problem discussed. 4,200 w. Forum—April, 1897. No. 11,945. 30 cts.

MONEY.

Money Without Law. Carlyle McKinley. Discusses means of adjusting the differences between the advocates and opponents of free coinage of silver. Suggests the adoption of gold and silver pieces of uniform weight and quality, as the only thing necessary to establish a perfect system of international money for all nations that adopt it. 3,200 w. Bankers' Mag N Y—March, 1897. No. 11,646. 45 cts.

RAILWAY Finance.

A Pivotal Movement in Finance. A discussion of the Lake Shore Railway refunding plan and its effect. 1,000 w. Bradstreet's—March 13, 1897. No. 11,564. 15 cts.

GOVERNMENT CONTROL.

ANTI-TRUST Law.

Railroad Agreements Under the Anti-Trust Law. Discusses the decision in the action brought by the United States Government against the Trans-Missouri Freight Assn. Also some of the effects of the decision. 2,200 w. Bradstreet's—March 27, 1897. No. 11,896. 15 cts.

TRUSTS.

Investigation of the "Rubber Trust." Comments on the investigations of the United States Rubber Co. 2,500 w. Ind Rub Wld—March 10, 1897. No. 11,650. 45 cts.

The Lexow Anti-Trust Report. Comment on the report of the New York State Investigating Committee, reviewing the work and what was accomplished. 2,500 w. Gunton's Mag—April, 1897. No. 12,006. 30 cts.

Views of an Anti-Monopolist on Trusts. A statement of Mr. Thurber's views as presented to the Lexow Committee in New York. 1,600 w. Gunton's Mag—April, 1897. No. 12,007. 30 cts.

LABOR.

EIGHT-Hour Day.

How to Attain the Eight-Hour Day. Rev. Jesse H. Jones. Suggestions for the attainment of this end and arguments showing that business will be as profitable as on the ten-hour system. 2,000 w. Gunton's Mag—March, 1897. No. 11,487. 30 cts.

JAPAN.

Conditions of Labor in Japan. Fusataro Takano. Presents the life conditions of the typical classes of Tokyo workers who represent Japanese laborers of the whole country in many respects. 2,800 w. Gunton's Mag—April, 1897. No. 12,005. 30 cts.

PADRONE System.

The Padrone System and Padrone Banks. John Koren. Describes the system as practised in the United States some thirty years ago, which no longer exists, and what is termed the padrone system at the present time, with other matters relating to Italian labor; also the peculiar system of banking in vogue among the Italians of this country. 8,000 w. Bul of Dept of Labor—March, 1897. No. 11,647. 45 cts.

STRIKE.

An English Railroad Strike. W. M. Acworth. A brief account of the recent strike on the Northeastern Railway of England. 1,200 w. R R Gaz—March 26, 1897. No. 11,889. 15 cts.

The Collapse of the Northeastern Strike. Short account of the trouble and its settlement. 1,800 w. Trans—March 5, 1897. No. 11,605. 30 cts.

TRADE UNIONS.

Organized Labor Abroad. Evidence of the progress of trade-unionism abroad. 1,600 w. Gunton's Mag—March, 1897. No. 11,489. 30 cts.

The Engineers' Dispute. Editorial discussion of labor troubles in England, with letters sent by employers to the Amalgamated Soc. 2,800 w. Engng—March 5, 1897. No. 11,598. 30 cts.

WORKMEN'S Houses.

See same title under Architecture and Building—Construction and Design.

MISCELLANY.

CANADA.

The Progress of Canada During the Six-

ty Years of Her Majesty's Reign. J. G. Colmer. A description of Canada as it was, of some of the prominent events in the last sixty years, and Canada as it is to-day. Short discussion follows. 10,500 w. Jour Soc of Arts—March 5, 1897. No. 11,590. 30 cts.

CHINA.

See same title under Electrical Engineering—Miscellany.

JAPAN.

Railroad and Industrial Improvements in Japan. Calls attention to the efforts made by this government to investigate the methods of railroads in the United States and Europe, and to make themselves masters of allied industries. 900 w. No. 11,885. 15 cts.

LUMBER Industry.

Modern Logging in the Northwestern States. Edward K. Bishop. Describing the improved methods of yarding and hauling logs in an Oregon logging camp. Ill. 3,200 w. Eng Mag—April, 1897. No. 12,051. 30 cts.

NETHERLANDS.

The Dutch Society for General Welfare. J. Howard Gore. A study of the work accomplished by this society in Amsterdam, whose purpose is to "advance general prosperity and to strive for the promotion of the intellectual, moral and social condition of the people, especially by fostering education, by ennobling their concept of life, by increasing the earning capacity of the wage earner and by enabling him to better enjoy the fruits of his labor." 9,000 w. Bul of Dept of Labor—March, 1897. No. 11,648. 45 cts.

NICARAGUA Canal.

See Civil Engineering, Canals, Rivers and Harbors.

PROSPERITY.

What Will Bring Prosperity? Charles Stewart Smith and Francis B. Thurber. Mr. Smith recommends fair play to honest industry, whether represented by private workers or organized capital, and the dispelling of all doubt as to the circulating medium of the country (the United States). Mr. Thurber suggests six important steps that should be taken, the first being the settlement of finances. 2,800 w. N Am Rev—April, 1897. No. 11,976. 45 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

BLEACHING.

The Sulphite and Electric Works at Hallein. (Die Sulphit und Elektrischen Anlagen in Hallein.) An account of the new paper pulp works at Hallein, near Salzburg, in which the bleaching is performed by Dr. Kellner's process of sulphite and electric current. 1,500 w. Elektrochemische Zeitschr—Feb., 1897. No. 11,771. 45 cts.

CARBON Element.

Experiments Upon the Carbon Element. (Untersuchungen über die Vorgänge im Kohle-Element.) Experiments in the production of electricity by the solution of carbon in melted caustic potash, with reference to the researches of Dr. Jacques and Mr. Reed, made in the laboratory of the Hagen Accumulator Works. 3,000 w. and many diagrams. Zeitschr für Elektrochemie—Feb. 20, 1897. No. 11,768. 30 cts.

FURNACES.

Electric Furnaces. J. Warren. Description of some of the most notable furnaces constructed with a view to transforming ordinary carbon into its denser modifications. Ill. 2,000 w. Elec, Lond—March 12, 1897. Serial. 1st part. No. 11,800. 30 cts.

A Simple Form of Electric Furnace. (Ueber eine geeignete Form des Elektrischen Ofens.) A small furnace, suitable for the production of calcium carbide or carborundum, made of solid blocks of carbon. 1,500 w. Zeitschr für Elektrochemie—Feb. 5, 1897. No. 11,766. 30 cts.

METALLURGY.

Metallurgical Applications of Electric Heating. H. Poisson, in Revue Industrielle. Describes processes and furnaces. Ill. 2,200 w. Sci Am Sup—March 20, 1897. No. 11,671. 15 cts.

LIGHTING.

ALTERNATING Currents.

Alternating Current Working. H. E. Raymond. Suggestions intended to aid the inexperienced in the practice of alternating-current transmission. 1,600 w. Am Elect'n—March, 1897. No. 11,780. 15 cts.

ARC.

Curious Freak of a Voltaic Arc. Brief illustrated description of irregular performance, and the cause and remedy. 500 w. W Elec—March 27, 1897. No. 11,901. 15 cts.

ARC Lamps.

Regulation of Arc Lamps. Calls attention to the work that is being done in Europe. Three distinct types of arc lamp are presented; the Eck arc lamp, Klosterman lamp "la moderne" and Barrière table lamp. Ill. 2,200 w. W Elec—March 20, 1897. No. 11,797. 15 cts.

Whistling Arcs—A Case of Electrostatic Induction and the Remedy. Foree Bain. An account of a strange phenomenon and the experiments made to determine the cause, with the remedy adopted. 3,300 w. W Elec—March 6, 1897. No. 11,468. 15 cts.

CAR LIGHTING.

The Electric Lighting of the Austrian Railway Post-Offices. (Die Elektrische

Beleuchtung von Eisenbahn Postwagen in Oesterreich.) Illustrated description of the system of incandescent lamps and storage batteries used in the railway post-office cars in Austria. 2,500 w. Elektrotechnische Zeitschr—March 4, 1897. No. 11,765. 30 cts.

COAST Defense.

The Electric Light for Coast Defense. M. A. Boyd. Synopsis of a lecture as given in an English journal, giving views held abroad on this subject after practical tests. 900 w. W Elec—March 13, 1897. No. 11,581. 15 cts.

COLD Light.

A Cold Light. A brief account of experiments now being carried out in Europe by Puluj. 700 w. Bos Jour of Com—March 27, 1897. No. 11,921. 15 cts.

ELECTRIC Light.

See "Electric Light," under Marine Engineering.

DECORATIVE Lighting.

The Electrical Features of the Inaugural Ball. Louis Denton Bliss. Illustrated description of the electrical decorations. 2,000 w. Am Elect'n—March, 1897. No. 11,778. 15 cts.

DISTRIBUTION.

Principles of Electrical Distribution. Francis B. Crocker. Studied chiefly from the development in electric lighting. Part first deals with the series system of distribution. 6,000 w. Sch of Mines Quar—Jan., 1897. Serial. 1st part. No. 11,987. 45 cts.

FAULTS.

A Direct-Reading Fault Localizer. F. Charles Raphael. Illustrated description of instrument to facilitate the localization of faults in light and power cables. 1,000 w. Elect'n—March 12, 1897. No. 11,849. 30 cts.

FIRES.

The Prevention of Fires Due to Leakage of Electricity. Frederick Bathurst. The Fothergill prize essay. Gives a review of the present methods of wiring and reasons for advocating insulating tubing. Discussion follows. 7,500 w. Jour Soc of Arts—March 12, 1897. No. 11,835. 30 cts.

HIGH-VOLTAGE.

The 1897 High-Voltage Lamp. The progress made during the past year. Ill. 1,100 w. Elect'n—March 5, 1897. No. 11,-653. 30 cts.

INCANDESCENT Lamps.

Exhausting Lamps by the "Chemical" Method at the Edison Lamp Works. Describes the method used and states its advantages. Ill. 1,000 w. Elec Eng—March 31, 1897. No. 11,954. 15 cts.

Street Lighting in England by Incandescent Lamps. A few facts and opinions on the advantages and disadvantages of the system, from experts and practical men of England. 2,100 w. Elec Wld—March 20, 1897. No. 11,813. 15 cts.

The Selection of Incandescent Lamps for Use in Trolley Cars. W. Sonneberg. Points out the necessity for discrimination. 1,100 w. Am Elect'n—March, 1897. No. 11,781. 15 cts.

INSULATION and Resistance.

Investigations Upon Electric Plants. (Untersuchung von Elektrischen Anlagen.) A brief outline of the methods of measuring the insulation and resistance of electric lighting systems. 1,000 w. Glaser's Annalen—Feb. 15, 1897. No. 11,717. 45 cts.

On the Measurement of the Insulation Resistance of Continuous Current Three-Wire Systems While at Work. Edwin J. Houston and A. E. Kennelly. A response to criticism of method of the writers by Maurice Travailleur in L'Eclairage Electrique. 1,500 w. Elec Wld—March 6, 1897. No. 11,499. 15 cts.

ISOLATED Plant.

The Isolated Plant at the Hillside House, Scranton, Pa. H. B. Coho. Illustrated detailed description of the interesting features of this plant. 1,800 w. Elec Eng—March 31, 1897. No. 11,955. 15 cts.

LAMP Testing.

Lamp Testing Bureau Proposed for the National Electric Light Association. President Nichol's plan for establishing a lamp testing-bureau. 1,800 w. Elec Eng—March 10, 1897. No. 11,498. 15 cts.

LIGHTING.

Electric Lighting. Henry Stooke. Part first consists of an introduction of subject and definition of arc lamp. Ill. 900 w. Ill Car and Build—Feb. 26, 1897. Serial, 1st part. No. 11,509. 30 cts.

MUNICIPAL Lighting.

Municipal Lighting Reports. George S. Thayer. Calls attention to some reasons why municipal ownership does not pay, and quotes reports from various places. 1,500 w. Elec Eng—March 24, 1897. No. 11,864. 15 cts.

Notes on the Electric Lighting of Fort William. Illustrated description of the installation of a town in Scotland, the first in that country to be lighted by means of water power. 1,300 w. Elec Rev, Lond—March 5, 1897. No. 11,654. 30 cts.

The Municipal Electric Lighting Plant at Frankfort-on-the-Main. Describes the design of the station, the distributing system and the operation of the plant. Ill. 1,900 w. Eng Rec—March 20, 1897. No. 11,807. 15 cts.

PHOTOMETRY.

The Question of Photometric Units. (Zur Frage der photometrischen Einheiten.) An argument for the establishment of international units of strength, brill-

iancy, efficiency, &c., of light, similar to the electrical units already in use. 3,500 w. Elektrotechnische Zeitschrift. Feb. 18, 1897. No. 11,761. 15 cts.

VACUUM TUBE.

Vacuum Tube Lighting. M. A. Edson. Read before the Chicago Electrical Assn. Discusses the various sources of artificial illumination and the problem of reflection and diffusion of light, with a review of the work done in vacuum tube lighting. 2,800 w. W Elec—March 6, 1897. No. 11,-469. 15 cts.

POWER.

ALTERNATORS.

The Maximum Output of Alternators. Dugald C. Jackson. Gives theoretical formulas which apply with a considerable degree of accuracy to the only machine with which the writer had an opportunity to experiment. 6,500 w. Elec Wld—March 20, 1897. No. 11,812. 15 cts.

DYNAMO.

A New Three-Wire Dynamo. T. R. D. Kenny. A discussion of the advantages of the machine. 1,600 w. Elec Rev, Lond—Feb. 26, 1897. No. 11,521. 30 cts.

Dynamo Connections — Circuits and Methods of Operating. Frank R. Jones. The first of a series of papers aiming to show some of the different modes of connecting dynamos to their circuits, the method of control and the operations of starting and stopping the machines when so connected. Tradesman—April 1, 1897. Serial. 1st part. No. 12,022. 15 cts.

Equalizing Connections for Compound-Wound Dynamos Coupled in Multiple. E. R. Keller. Shows the action of compound machines together with the equalizer connection and the function which it has to perform, giving methods of attaining the end desired. 2,700 w. Jour Fr Inst—March, 1897. No. 11,451. 45 cts.

ELECTRICITY.

The Handling of Electric Circuits, Arcs, &c. A. J. Wurts. Abstract of a lecture delivered before Sibley College. Deals with the handling of alternate and direct currents, describing apparatus, especially the Wurts switches. Ill. 3,500 w. Lib Jour of Engng—March, 1897. No. 11,681. 30 cts.

FAULTS.

See same title under "Lighting."

GENERATION of Electricity.

The Present Status of the Direct Generation of Electricity from Fuel. (Ueber die bisherigen Bestrebungen, Elektricität unmittelbar aus Brennstoffen zu erzeugen.) A historical review of the subject from the time of Mayer to the present day. Paper read before the Electrotechnic Society by Dr. Weber. 2,500 w. Elektrotechnische Zeitschr—Feb. 25, 1897. No. 11,763. 30 cts.

INDUCTION Coils.

An Improved Automatic Interrupter for Induction Coils. H. Lyman Sayen and Elmer G. Willyoung. Describes a new form of automatic interrupter, possessing many advantages over other forms. 1,000 w. Jour Fr Inst—March, 1897. No. 11,453. 45 cts.

INTER-CONNECTION.

Destruction of the Philadelphia Traction Company's Mount Vernon Street Station. Illustrated description, with diagram giving an idea of situation. 1,200 w. Elec Wld—March 13, 1897. No. 11,589. 15 cts.

ISOLATED Plant.

Electric Plant of the St. Paul Building, New York City. General description of the building, with illustrated detailed description of the electrical plant. 2,800 w. Elec Wld—March 27, 1897. No. 11,926. 15 cts.

LOSSES.

The Separation of the Losses of Three-Phase Motors and a Comparison of the Losses on Balanced and Unbalanced Circuits. Ernest B. True. Gives method of testing and the results. 2,000 w. Wis Eng—Jan., 1897. No. 11,854. 30 cts.

MINING.

See "Electricity" and "Hoisting," under Mining and Metallurgy, Mining and Coal and Coke.

MOTORS.

Electric Motors at the Baldwin Locomotive Works. Describes a change in machine shop practice. In place of the long line shafting to which the machines were belted, independent electric motors are used. Information in regard to the present status of the work of changing the shop methods. 2,200 w. RR Gaz—April 2, 1897. No. 12,002. 15 cts.

The Theory of Constant Speed Direct Current Motors. W. G. Rhodes. Investigates the compounding of motors so as to maintain a constant speed under all loads, up to a certain limit. 800 w. Elec Rev, Lond—Feb. 26, 1897. No. 11,522. 30 cts.

POLYPHASE.

Polyphase Electric Currents. Sketches briefly the chief features of the system. 1,400 w. Eng, Lond—March 19, 1897. No. 11,914. 30 cts.

POWER Station.

The Electric Plant at Rathausen, near Lucerne. (Das Elektricitätswerk Rathausen bei Luzern.) An extensive illustrated description of the new hydraulic electric plant near Lucerne—900 H. P. now in use, and at present being increased to 1,500 H. P. 7,500 w. Elektrotechnische Zeitschr—March 4, 1897. No. 11,764. 30 cts.

Design and Construction of Electric Power Plants. Broic J. Arnold. Part first discusses the possible sources of energy. 5,500 w. W Elec—April 3, 1897. No. 12,023. 15 cts.

PUMPING.

The Pumpinf Plant for Condensing Water at the Berlin Sxhibition, 1896. (Kondenswasser-Pumpenanlage auf der Berliner Gewerbeausstellung, 1896.) An account of the performance of two electrically driven centrifugal pumps, with table of data and efficiency. 1,200 w. Zeitschr d Ver deutscher Ing—Feb. 6, 1897. No. 11,704. 30 cts.

RESISTANCE.

A Simple Way of Testing the Resistance of a Field Coil When Instruments Are Not Available. Frank B. Porter. A simple device for testing the electrical resistance of a field. 600 w. Elec Wld—March 13, 1897. No. 11,587. 15 cts.

RHEOSTATS.

On the Construction and Calculation of Rheostats. P. M. Heldt. Considers only rheostats in which the resistance material is metallic wire. Illustrated description of dynamo field rheostats, motor-starting rheostats and motor-regulating rheostats. 2,500 w. Am Elect'n—March, 1897. No. 11,779. 15 cts.

ROCK Drilling.

Electric Rock Drilling by the Société de Charbonnages des Bouches-du-Rhone. Albion T. Snell. Particulars taken from a description by M. M. H. Dubs in the Bulletin de la Société Scientifique de Marseille of the Galerie de la Mer. Ill. 2,200 w. Elect'n—Feb. 26, 1897. No. 11,517. 30 cts.

STATION.

Light and Power Station at the Altofen Shipyards. (Elektrische Kraft und Lichtzentrale auf der Altofner Schiffswerft.) An illustrated account of the plant of the Danube Steam Navigation Company. Over 400 H. P. is distributed over the yards among small motors, besides 400 H. P. in lighting. 3,500 w. Zeitschr d Ver deutscher Ing—Feb. 27, 1897. No. 11,712. 30 cts.

See also "Boston" under Street and Electric Railways, Power; "Electricity" under Mining and Metallurgy, Mining, and "Station" under Street and Electric Railways.

STEAM ENGINE.

The Selection of a Power Plant Steam Engine. Abstract of a lecture delivered by Prof. Hutton at the rooms of the Amer. Inst. The questions discussed were high and low-speed engines, automatic cut-off engines as contrasted with throttling engines, and the arguments in favor of condensing engines. 1,500 w. Elec Wld—March 13, 1897. No. 11,586. 15 cts.

STORAGE BATTERY.

Storage Battery Engineering Practice. Joseph Appleton. Part first consists of introductory remarks and an explanation of the construction and operation of storage batteries. 1,600 w. Elec Eng—March 17, 1897. No. 11,620. 15 cts.

The Bowling Green Storage Battery Station of the New York Edison Co. A short account of the objects for which the battery has been installed and the work it accomplishes, with illustrated detailed description. 1,800 w. Elec Eng—March 10, 1897. No. 11,496. 15 cts.

The influence of Manganese in Accumulators. (Ueber den Einfluss von Manganverbindungen auf Bleiakkumulatoren.) An investigation of the action of the superoxide of manganese in storage batteries. Its presence is declared to be unfavorable, causing the battery to run down more rapidly when at rest. 1,500 w. Zeitschr f Elektrochemie—Feb. 20, 1897. No. 11,769. 30 cts.

TRACTION.

Electrically Driven Vehicles. A topical discussion opened by Mr. Andrew L. Riker. 1,200 w. Trans Am Inst of Elec Engs—Jan., 1897. No. 11,583. 45 cts.

TRANSFORMERS.

Rotary Transformers. J. E. Woodbridge. Description of a device without moving wire, which will perform the duties of both "static" and "rotary" transformers. 900 w. Elec Wld—March 27, 1897. No. 11,927. 15 cts.

Transformer Regulation. Joseph Bijur. An investigation of the causes which produce a drop of potential. 3,200 w. Elec Wld—March 27, 1897. No. 11,928. 15 cts.

TRANSMISSION.

Long Distance Electrical Transmission in California. Illustrated detailed description of the electrical transmission water power plant of Fresno. 4,000 w. Eng, Lond—March 5, 1897. No. 11,592. 30 cts.

Power Transmission on the Continuous Current Series System. J. S. Hecht. The principal characteristics of the series system, with description. Ill. 4,200 w. 25 and March 4, 1897. No. 11,762. 90 cts.

The Regla-Pachuca Power Transmission. George J. Henry. It is the purpose of the article to give a complete description of a high head water power and electric transmission plant in Mexico, and to point out what improvement may be effected in the development of mining and other industries in localities difficult of access. Ill. 2,700 w. Elec Wld—March 13, 1897. Serial. 1st part. No. 11,588. 15 cts.

Three-Phase Transmission. F. C. Armstrong. Illustrated description of three-phase transmission plant in the Montreal Cotton Company's mills, Valleyfield, Que. 800 w. Can Eng—March, 1897. No. 11,569. 15 cts.

TELEGRAPHY AND TELEPHONY.

AUTOMATIC Telephone.

Telephone System Without Calling De-

vice for Subscribers. (Fernsprechanlage-ohne Rufstromquellen bei den Theienehmerstellen.) Description of an automatic system by means of which the unhooking and hooking up of the receiver gives the call or rings off. Three articles. 5,000 w. Elektrotechnische Zeitschrift—Feb. 18 and 25 and March 4, 1897. No. 11,762. 90 cts.

BERLINER.

The Berliner Patent. Morgan Brooks. A suggestion regarding the legal status of this telephone patent, not previously brought out. 1,100 w. Elec—March 10, 1897. No. 11,530. 15 cts.

CABLE.

A Novel Method of Lifting a Buoyed Cable End. F. Alex Taylor. Brief description of the usual method as given by H. D. Wilkinson, with description also of a novel plan suggested and applied by a French telegraph engineer. 500 w. Elect'n—Feb. 26, 1897. No. 11,519. 30 cts.

Repairing Submarine Cable. H. Benest. On some repairs to the South American Company's cable off Cape Verdi in 1893 and 1895. A brief résumé of the establishment of the submarine telegraph between the coasts of Africa and Brazil, with some novel features affecting the cables. 3,300 w. Engng—March 12, 1897. Serial. 1st part. No. 11,831. 30 cts.

The "Rapid" Cable. Arthur Dearlove. Gives details of some observations made on two sections of a laid cable to determine the value of leak circuits. The results are not favorable. 900 w. Elect'n—Feb. 26, 1897. No. 11,518. 30 cts.

Telephone Cables. Dr. V. Wietlisbach. Talking through cables is considered, with the difficulties; how to overcome them by proper construction. 3,500 w. Elec Engng—April 1, 1897. No. 11,973. 25 cts.

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CABLE Testing.

Cable Testing. George D. Hale. Considers the questions: (1) How to manufacture such as will be suitable? (2) How to test the same during and immediately following the process of manufacture? (3) How to prevent their deterioration when laid? (4) How to locate the trouble in them when it arises? 1,800 w. W Elec—April 3, 1897. No. 12,024. 15 cts.

EXCHANGES.

Benefits Derived from Opposition Telephone Exchanges. C. E. Cory. Presentation of the benefits that telephone subscribers in Fort Scott have derived from competition; with editorial comment. 2,400 w. Elec Engng—April 1, 1897. No. 11,-975. 25 cts.

The New Dey Street Telephone Building, New York City. Herbert Laws Webb. Illustrated detailed description of what is practically an enlargement of the present building. 5,500 w. Elec Eng—March 17, 1897. No. 11,620. 15 cts.

FIRE-ALARM.

Some Requisities of a Perfect Fire-Alarm Box. James W. Johnson. Read before the Illinois Firemen's Assn. Points out a few of the essential features that should be embodied in all boxes to render them reliable and efficient under the many and varying conditions. 1,200 w. W Elec—March 20, 1897. No. 11,798. 15 cts.

RESONANCE.

Some Practical Aspects of Electrical Resonance. Kempster B. Miller. Read before the Chicago Elec. Assn. Briefly outlines the underlying principles of resonance, and its relation to telegraphy and telephony. 3,700 w. W Elec—March 13, 1897. No. 11,579. 15 cts.

STORAGE Battery.

The Storage Battery in Telegraph Work. Maurice Barnett. Discusses their lower first cost, their lower maintenance cost, the smaller floor space required by them and their more satisfactory performance in service. Ill. 2,200 w. Am Elect'n—March, 1897. No. 11,783. 15 cts.

TELEPHONES.

How to Make a Telephone. E. E. Clement. Directions with illustrations. 2,000 w. Am Elect'n—March, 1897. No. 11,784. 15 cts.

TELEPHONY.

Long Distance Work. Dr. V. Wietlisbach. A careful discussion of all phases of long distance work and the methods and devices used. Ill. 25,900 w. Elec Engng—April 1, 1897. No. 11,972. 25 cts.

MISCELLANY.

ALUMINUM.

Recent Determinations of the Electrical Conductivity of Alumnium. Joseph W. Richards and John A. Thomson. Gives the causes of the various values determined for the electrical conductivity of this metal, with experiments and conclusions. 900 w. Jour Fr Inst—March, 1897. No. 11,450. 45 cts.

BATTERIES.

Two New Galvanic Elements. (Ueber zwei neue Galvanische Elemente.) The first is composed of two carbons, one in porous cell in clorine water, the other without in hyposulphite of soda; electromotive force 0.47 volt, very constant. The second is composed of an iron anode and carbon cathode in a concentrated solution of cloride of iron. Very constant; electromotive force 0.9 volt. 1,500w. Zeitschr d Elektro Chemie. Feb. 5, 1897. No. 11,767. 30 cts.

BURGLAR-PROOF.

The Modern Burglar. Carl E. Kammeyer. Illustrated description of work on safes by burglars with electricity, with description of protective device. 900 w.

Elec Rev. March 17, 1897. No. 11,619. 15 cts.

CELL.

The Lead Cell. B. E. Moore. A theoretical and experimental study, with results. 6,000 w. Phys Rev. March-April, 1897. No. ..,506. 45 cts.

CHARGES.

Methods of Charging for Electricity Supply. R. P. Wilson. Read before the Northern Soc. of Elec. Engs., Manchester, Eng. Names the systems in use, states the objects of any system, and considers the merits of the systems named. Ill. 3,400 w. Elec. March 24, 1897. No. 11,869. 15 cts.

CHINA.

Electricity and Electrical Engineering in China and Japan. R. Van Bergen. The writer gives but little encouragement to American enterprise in Japan, but considers China more hopeful, making suggestions as to the best way to secure attention. 1,000 w. Elec Eng. March 10, 1897. No. 11,497. 15 cts.

CURRENT.

The Insulating Medium Surrounding a Conductor the Real Path of Its Current. E. J. Houston and A. E. Kennelly. A brief description of the manner in which electric current is believed to be transmitted. Abstract of a paper road before the Am. Phil. Soc. 2,500 w. Elec Wld. March 27, 1897. No. 11,929. 15 cts.

ELECTRIC ENERGY.

Work in the Electric Current. (Ueber die Stromarbeit.) A mathematical discussion of the mechanical laws of energy applied to the flow of electricity. 3,500 w. Electrochemishe Zeitschr. Feb., 1897. No. 11,770. 45 cts.

ELECTRICITY.

Epoch-Making Events in Electricity. G. H. Stockbridge. Describing Volta's experiments and the succession of electricity of motion to that of tension. Ill. 4,200 w. First paper. Eng Mag. April, 1897. No. 12,049. 30 cts.

GERMINATION.

Amherst Experiments on the Electro Germination of Plants. Extended abstract from a bulletin issued by the Hatch Experiment Station of the Massachusetts Agricultural College describing a series of experiments carried out by Mr. Asa S. Kinney. Ill. 2,400 w. Elec Eng. March 17, 1897. No. 11,622. 15 cts.

MAGNETISM and Light.

The Latest Discovery in Physics. Oliver Lodge. Reviews the work of Faraday and others, giving special attention to the discovery of Dr. P. Zeeman. 2,500 w. Elect'n. Feb. 26, 1897. No. 11,516. 30 cts.

MAGNETO-ELECTRICITY.

On the Mechanical Conceptions of Electricity and Magnetism. W. S. Franklin. Read before the Buffalo meeting of the Am. Assn. Develops the conceptions of the dependence of electromotive force upon changing magnetic flux, of the dependence of magneto-motive force upon changing electric flux, of the production of electro-motive force in a moving wire, of the energy stream, of electro-magnetic waves, and of the Hertz vibrator. 3,000 w. Phys Rev—March-April, 1897. No. 11,508. 45 cts.

RADIOGRAPHY.

Recent Progress in Instantaneous Radiography. (Les progrès Récents de la Radiographie Instantanée.) An account of the methods and apparatus by means of which M. Colardeau has succeeded in obtaining radiographs in the 250th part of a second. 1,500 w. Le Génie Moderne—Feb. 15, 1897. No. 11,748. 30 cts.

RESONANCE.

Electric Resonance and Consonance. (Ueber Elektrische Resonanz und Konsonanz). Two papers by Herr C. P. Feldmann, giving an analytical investigation of the theory with graphical applications. 7,500 w. Elektrotechnische Zeitschr—Feb. 18 and 25, 1897. No. 11,-772. 30 cts.

ROENTGEN RAY.

On the Manipulation of Röntgen-Ray Apparatus. George T. Hanchett. The experimental experience of the writer with a number of tubes under varying conditions. 1,200 w. Elec Wld—March 20, 1897. No. 11,811. 15 cts.

SAFES.

Burglarizing Safes by Electric Heat. Is It Feasible? Discusses recent articles that have appeared setting forth this new danger threatening safes, and quotes the authority of expert electricians in proof that there is no need of great anxiety on the subject. 3,400 w. Elec Eng—March 31, 1897. No. 11,956. 15 cts.

STEEL.

The Influence of Heat Treatment Upon the Magnetic Properties of Hardened Steel. Dr. K E. Guthe. Abstract of a paper presented at meeting of Am. Inst. of Elec. Engs. A contribution to knowledge of the dependence of magnetic properties upon the percentage of carbon present and the character of the heating. A report of careful investigations. 2,500 w. Elec Wld—March 27, 1897. No. 11,925. 15 cts.

SUBWAYS.

The Electrical Subways in Utica, N. Y. Illustrated description of the city subways and account of their cost. 900 w. Eng Rec—March 6, 1897. No. 11,457. 15 cts.

X RAYS.

X-Rays, Apparatus and Methods. Elmer G. Willyoung and H. Lyman Sayen. Discusses apparatus and methods for practical work, with especial reference to the needs of the physician and surgeon. Ill. 7,000 w. Jour Fr Inst—March, 1897. No. 11,452. 45 cts.

See also Radiograph and X Ray, above.

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BATTLESHIPS.
Thames-Built Battleships. Illustrations and general description of the Fuji, built for the Japanese Navy by Thames Iron Works. 4,400 w. Engng—March 12, 1897. No. 11,829. 30 cts.

COAST Defense.
See same title under Electrical Engineering—Lighting.

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Compressed Air System on the United States Monitor Terror. Engravings and description of duties performed by compressed air. 2,000 w. Sci Am—March 20, 1897. No. 11,667. 15 cts.

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Collapse of a Pair of Corrugated Furnaces. From the "Locomotive." Illustrated description of an accident which took place in one of the four compound marine boilers of the whaleback steamer City of Everett. 800 w. Ir Age—March 11, 1897. No. 11,532. 15 cts.

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Liquid Fuel Under Marine Boilers. (Heizung der Schiffskessel mit flüssigem Brennstoff.) A general statement of the advantage of liquid fuel, and a resumé of the results obtained in actual practice. 2,000 w. Glaser's Annalen—March 1, 1897. No. 11,721. 30 cts.

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Electric Light Plants for the British Navy. Illustrated description of a pattern of combined engine and dynamo set designed for the ships "Majestic," "Magnificent," "Terrible," "Powerful," "Diadem" and "Andromeda" class. 300 w. Elec'n—March 5, 1897. No. 11,652. 30 cts.

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Screw Propellers for Canal-Boats. Henry Barcroft. Consideration of the principles involved in the action of partially immersed screw propellers for canal-boats, with the experience resulting from experiments and observations on the influence of section of waterway upon the progress of canal-boats. Ill. 3,300 w. Engng—Feb. 26, 1897. No. 11,505. 30 cts.

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Mechanical Propulsion on Canals. Leslie S. Robinson. Part first reviews early investigations, with study of resistance on rivers. 3,000 w. Ind & Ir—March 5, 1897. Serial. 1st part. No. 11,604. 30 cts.

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U. S. Monitor "Puritan." Illustrated description of the largest craft of her class. 1,100 w. Eng, Lond—March 19, 1897. No. 11,915. 30 cts.

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Resistance of Ships and Other Floating Bodies at Deep and Shallow Drafts of Water. Joseph R. Oldham. Convictions and opinions held by eminent scientists and engineers on the resistance offered by water to ships floating therein are examined, with general remarks. 5,000 w. Jour Assn of Engng Soc—Feb., 1897. No. 11,892. 30 cts.

RACING.
The Prevention of Racing in Marine Engines. L. Harlan. Describes invention of J. S. Yabsley, of Yokohama, to effect by electrical means the closing and opening of a throttle valve, which regulates the supply of steam to the engines. Ill. 1,200 w. Elec Rev, Lond—Feb. 26, 1897. No. 11,520. 30 cts.

SHIPBUILDING.
About Merrimac Ship Building. Horace C. Hovey. Facts of interest concerning the history and progress of ship building. Ill. 1,400 w. Sci Am—March 13, 1897. No. 11,534. 15 cts.

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American Merchant Shipping. Editorial discussion of ideas advanced by Captain Alexander McDougall. 1,600 w. Eng, Lond—March 19, 1897. No. 11,918. 30 cts.

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The New German Mail Steamer König. Illustrated description of a new steamer in service between Hamburg and the German colonies in East Africa. 500 w. Sci Am Sup—March 13, 1897. No. 11,535. 15 cts.

The Plant Line Steamship "La Grande Duchesse." Illustrated description of new steamship running between New York and Savannah. 700 w. Eng News—March 25, 1897. No. 11,879. 15 cts.

The Niger stern-wheel steamers "Empire" and "Liberty." Two-page plate with description. 1,400 w. Engng—March 12, 1897. No. 11,828. 30 cts.

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Our Warships. William Allan. A criticism of modern ships showing that fitted with boilers, as they have been and are being at present, are not reliable, are far from safe, and not the best. 3,000 w. Contemporary Rev—March, 1897. No. 11,643. 45 cts.

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O'Brien's Water-tight Doors for Ships.

Illustrated description. 800 w. Steamship—March, 1897. No. 11,572. 30 cts.

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Salt-Water Feed for Express Boilers. Details of experiments made by Messrs. Yarrow & Co., in which salt water was used as feed, showing that in case of a complete breakdown of the condenser a vessel fitted with these small tube boilers would be safe for a considerable distance of steaming. 1,700 w. Engng—March 19, 1897. No. 11,906. 30 cts.

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Water-Tube Boilers for H. M. S. "Pelorus." Drawings of boilers and engines, with description. The small-tube boiler was adopted for the first time in cruisers, and results of trials are given. 1,400 w. Engng—March 19, 1897. No. 11,908. 30 cts.

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The Twin-Screw Yacht Varuna. Illustrated description of yacht built for Mr. Eugene Higgins, of New York, by Messrs. A. & G. Inglis, of Glasgow. 1,500 w. Eng, Lond—Feb. 26, 1897. No. 11,514. 30

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER.

The Steam Boiler. Stephen Christie discusses the effect of location and cites some of the requirements looked for in the selection of boilers. 2,000 w. Safety V—March, 1897. No. 11,623. 15 cts.

Progress in Heating Boiler Construction. Hugh J. Barron. A study of the boiler problem with sketches of work done by the writer. 700 w. Heat and Ven—March 15, 1897. Serial. 1st part. No. 11,826. 15 cts.

See also "Boilers" under Mining and Metallurgy Mining.

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Self-Supporting Metal Chimneys. C. G. Robbins. Discusses their design and construction. Ill. 5,800 w. Power—April, 1897. No. 12,016. 15 cts.

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Coal-Handling for Large Boiler Plants. Illustrated description of the manner in which the problem has been worked out at the Ridgewood Pumping Station of the Brooklyn Water-Works and at the power stations of two of the Brooklyn street railway companies. 1,300 w. Sci Am Sup—March 20, 1897. No. 11,669. 15 cts.

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Limitations of the Efficiency of Steam Boilers. Editorial calling attention to claims made in boiler tests that cannot be correct. 1,600 w. Eng News—March 18, 1897. No. 11,793. 15 cts.

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Boilers at Acushnet Mill, New Bedford, Explode. An account of an explosion which killed two employees and destroyed much personal property. 1,000 w. Bos Jour of Com—March 16, 1897. No. 11,475. 15 cts.

The New Bedford Explosion. Calls attention to interesting features in connection with a recent explosion. 1,600 w. Bos Jour of Com—March 20, 1897. No. 11,799. 15 cts.

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Boiler Feed Pumps. C. A. Collett. The abuses of the steam pump, with explanation of its construction and functions. 1,600 w. Am Electn—March, 1897. No. 11,782. 15 cts.

FEED-WATERS.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. Detailing the impurities that cause the formation of scale, and the methods of treating them. 7,400 w. Second paper. Eng Mag—April, 1897. No. 12,052. 30 cts.

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A Gas-Burning Water Heater or Steam Boiler. Illustrated description of invention of John S. Coe. 800 w. Am Mach—March 18, 1897. No. 11,662. 15 cts.

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The Exchanges of Heat Between the Steam and the Cylinder Walls. (Der Uebergang der Wärme Zwischen dem Dampf und den Wandungen der Dampfcylinder.) Prof. A. Fiegner. A valuable mathematical and graphical treatment of this important subject. Three articles. 10,000 w. Schweizerische Bauzeitung—Feb. 27, March 6 and 13, 1897. No. 11,737. 45 cts.

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The Certification of Boiler and Engine Attendants. Editorial discussion of the bill before the House of Commons to secure the granting of certificates to persons in charge of engines and boilers. 2,400 w. Engng—March 5, 1897. No. 11,599. 30 cts.

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Safety-Valve Practice. F. F. Hemenway. Discusses the requirements of safety-valves and the means of deciding on the area. 1,300 w. Am Mach—March 11, 1897. No. 11,537. 15 cts.

STEAM.

Some Notes on Steam-Raising. Frank Leslie Watson. Read before the Association of Yorkshire students of the Institution of Civil Engineering. Part first introduces the advantages of forced draught. Ill. 2,500 w. Elec Rev Lond—Feb. 26, 1897. Serial. 1st part. No. 11,523. 30 cts.

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The Steam Loop. Its use, the principles upon which it acts, &c. 1,300 w. San Plumb—March 15, 1897. No. 11,629. 15 cts.

WATER-TUBE Boilers.
Water Tube vs. Shell Boilers. W. Barnet Le Van. An account of comparative tests made between water-tube boilers and shell or horizontal flue boilers at the establishment of the Brush Electric Light Co., Philadelphia, in October, 1882. 3,500 w. Mach—march, 1897. No. 11,485. 15 cts.

See also same title under Marine Engineering.

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AIR Compression.
Theoretical Modes of Air Compression. Lemuel R. Hopton. A short outline of the various modes of compression, with a comparison of their efficiency and advantage. 1,500 w. Yale Sci M—March, 1897. No. 11,684. 30 cts.

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Hydraulic Air-Compressor Plant at Magog. Illustrated description of a 150 h. p. compression plant erected for the Dominion Cotton Mill Co. as a test system, by the Taylor Hydraulic Air-Compressing Co. 2,400 w. Can Eng—March, 1897. No. 11,567. 15 cts.

A Description of the 150-Horse Power Hydraulic Air Compressor Erected for the Dominion Cotton Mills Company, at Magog, Que. C. H. Taylor. Illustrated description with results of tests. 2,800 w. Can Min Rev—March, 1897. No. 12,038. 30 cts.

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See Civil Engineering—Canals, Rivers and Harbors.

LOCOMOTIVE.
Test of a Compressed Air Locomotive for the Anaconda Copper Mining Company. Description, illustration and data of tests, as obtained from H. K. Porter & Co., of Pittsburg. 1,200 w. Ry Rev—March 27, 1897. No. 11,952. 15 cts.

NAVAL Use.
See "Compressed Air" under Marine Engineering.

PAINTING.
See Railroad Affairs—Equipment.

SNOW PLOW.
See Street and Electric Railways.

TRACTION.
See "Air Cars" under Street and Electric Railways.

ENGINES AND MOTORS.

CONDENSERS.
Central Condensing (Balcke System.) C. Habermann. Describes a system used at several collieries and iron works in Germany, resulting in saving of coal. Ill. 1,500 w. Col Guard—March 12, 1897. No. 11,834. 30 cts.

DYNAMO Construction.
The Relative Size, Weight and Price of Dynamos, Electric Machines. Ernest Wilson. Read at meeting of Inst. of Elec. Engs., England. Investigates the way in which weight and price of dynamo-electric machines vary with the variation of the mass factor. Tables, curves and discussion. 3,000 w. Elec Eng, Lond—March 5, 1897. No. 11,593. 30 cts.

GAS Engines.
An Improvement in Gas Engines. (Eine Neuerung an Gaskraftmaschinen.) A paper before the Berlin branch of the society by Dr. Petreano, showing the odvantages of mixing and preheating the air and gas. 3,000 w. Zeitschr d Ver deutscher Ing—Feb. 6, 1897. No.

Recent Developments in Gas Engines. Dugald Clerk. Read before the Inst. of Civ. Engs. A review of advances made in the construction and efficiency of gas engines. Part first considers mainly the engines working in accordance with the Otto Cycle, with results of tests. Ill. 6,500 w. Eng News—April 1, 1897. Serial. 1st part. No. 12,013. 15 cts.

Gas and Gasoline Motors. From Revue Industrielle. Illustrated description of the Lair-Delay Gas Motor, exhibited at the Rouen Exposition. 1,200 w. Sci Am Sup—April 3, 1897. No. 11,981. 15 cts.

GASOLINE Motor.
A Small High Speed Gasoline Motor. W. O. Amsler. Illustrated description of a special design by Mr. Gottlieb Daimler, of Cronstadt, Germany. 1,700 w. Sib Jour of Engng—March, 1897. No. 11,683. 30 cts.

OIL Engines.
The Oil Machine. George Richmond. Historical review of oil engines, with methods used, and principles involved efficiency, &c. 4,500 w. Sch of Mines Quar—Jan., 1897. No. 11,990. 45 cts.

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The Rotary Steam Engine. R. H. Thurston. Stating that the prototypes of the most successful of recent forms of rotary engines date back to Hero, of Alexandria, and showing that this engine has usually failed to satisfy in all the essential characteristics of a good steam engine. Ill. 1,600 w. Sci Am—April 3, 1897. No. 11,979. 15 cts.

Rotary Pumps and Engines: Their Origin and Later Development. Historical review of the inventions of this class of engines, with illustrations. 1,800 w. Sci Am Sup—April 3, 1897. Serial. 1st part. No. 11,980. 15 cts.

STEAM Engines.
The steam engines at the Geneva Exhibition in 1896. (Die Dampfmaschinen auf der Schw. Landes-Ausstellung in Genf, 1896.) The first of a series of articles. This contains drawings and description of vertical compound engine by Sulzer Bros. of Winterlhur. 3,000 w.

Schweizerische Bauzeitung—March 13, 1897. No. 11,741. 30 cts.

VALVE Motions.

A Rational Method of Studying Valve Motions. Henry Hess. Method devised by the writer to trace and show up the performance of a certain complicated valve gear. Ill. 1,700 w. Mch—April, 1897. No. 12,029. 15 cts.

VALVE Setting.

Valve Setting on Steam Pumps. Details of valve gear as shown on the Deane, of Holyoke, pumps are given and discussed; also the Deane duplex pump, and a compound duplex pump. Ill. 1,800 w. Power—April, 1897. No. 12,015. 15 cts.

See also Electrical Engineering Power.

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Chemical Hints to Foundrymen. Guy R. Johnson. Read before the Foundrymen's Assn. The elements and their effects are considered seriatim. Seventeen tables of tests and analysis are given. 2,700 w. Ir Age—March 11, 1897. No. 11,531. 15 cts.

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Steel Cores. George L. Roby. Read before the Western Foundrymen's Assn. The advantage of using steel cores in foundry work. 1,200 w. Ir Tr Rev—March 25, 1897. No. 11,935. 15 cts.

CYLINDERS.

Strength of Thick, Hollow Cylinders. John H. Cooper. A comparison of the work and results of many writers, with data of actual performance. 2,500 w. Mach—March, 1897. Serial. 1st part. No. 11,484. 15 cts.

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Compound Dies. J. L. Lucas. Illustrations of compound dies and their work, with information regarding them. 1,100 w. Am Mach—March 18, 1897. No. 11,661. 15 cts.

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Some Records of Drill Testing. Describes experiments made by the writer tending to show the superiority of milled drills for the class of drilling used. 800 w. Am Mach—March 18, 1897. No. 11,663. 15 cts.

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A Decimal Gage for Wire and Sheet-Iron. R. W. Raymond. Summary of a report of Mr. Albert Ladd Colby, favoring the adoption of a decimal system of gaging all materials in thousandths of an inch. 1,600 w. Trans Am Inst of Min Engs—March, 1897. No. 11,961. 45 cts.

HINDLEY Worm.

The Construction of the Hindley Worm. An illustrated account of the methods of manufacture of these worms as practised at the works of the Sprague Electric Elevator Co. 1,000 w. Am Mach—March 25, 1897. Serial. 1st part. No. 11,859. 15 cts.

MACHINE Shop.

An Unique Manufacturing Establishment. The first of a series of articles purposing to give an idea of the factory of the National Cash Register Co., of Dayton, O., and of the spirit that pervades it. It is conducted on a plan in many respects different from the usual practice. Ill. 4,500 w. Am Mach—March 25, 1897. Serial. 1st part. No. 11,858. 15 cts.

MACHINE Shop Management.

Six Examples of Successful Shop Management. Henry Roland. Describing the pension, insurance and endowment features of the plan of earnings division in operation at the works of Alfred Dolge & Co. 4,800 w. Sixth paper. Eng Mag—April, 1897. No. 12,046. 30 cts.

TOOLS.

American Machine Tools Criticized by an English Engineer. H. Austin. Letter to the editor calling attention to imperfection in American tools. Also editorial comment. 1,400 w. Am Mach—March 25, 1897. No. 11,860. 15 cts.

SPRINGS.

Concerning Coiled Springs. E. T. Adams. Considers springs made of round steel wire wound on a cylindrical mandrel, the data being taken from tests made on a considerable number of springs, mostly governor springs. 1,800 w. Sib Jour of Engng—March, 1897. No. 11,682. 30 cts.

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Chainless Bicycles. (Les Machines sans Chaine.) Illustrated description of the Drzewiecki bicycles and tricycles, in which the chain is replaced by internal gear and pinion. 1,000 w. Le Génie Moderne—Feb. 15, 1897. No. 11,750. 30 cts.

The Evolution of the Safety Bicycle. Historical review of the progress of the rear driven chain geared safety. Ill. 2,800 w. Ir Age—April 1, 1897. No. 11,984. 15 cts.

CRUSHING.

Crushing, Grinding and Separating Machinery. An account of machines for crushing, grinding and separating materials that have been made by Messrs. Johnson & Sons, Leeds. Ill. 2,000 w. Engng—March 19, 1897. No. 11,905. 30 cts.

DRAWINGS.

The use of Shade Lines in Drawings. F. A. Halsey. An attempt to show that the light and shaded surface view is untenable and causes many lines to be drawn in a way which is the reverse of clear and would not be understood by many. Their purpose is to make the drawing plainer. 1,800 w. Am Mach—March 11, 1897. No. 11,538. 15 cts.

EDUCATION.

The Administration of Schools of Mechanical Engineering. (Ueber die technische Hochschulbildung der Maschinen-ingenieure. G. Leissner.) A long discussion, with symposium of opinions from various educators, upon the question of reform in technical education now being much agitated in Germany. 12,000 w. Glaser's Annalen—Feb. 15, 1897. No. 11,714. 45 cts.

Technical Education in Europe. Explains what is meant by a technical school and gives many interesting facts. 1,800 w. Bos Jour of Com—April 3, 1897. No. 12,027. 15 cts.

The Question of Trade Schools. (Zur Frage der Werkmeisterschulen.) A paper by Hr. Teichmann, before the Würtemberg branch, discussing the need of more practical technical education in Germany. 1,500 w. Zeitschr d ver deutscher Ing.—Feb. 20, 1897. No. 11,710. 30 cts.

The Technical High Schools of Austria and Their Future. (Die technischen Hochschulen Oesterreichs und ihre Zukunft.) An address delivered before the Rectors and Professors of the technical schools of Vienna, comparing the income and facilities of the schools of Austria with those of other countries and urging advance and improvement. Two articles with four plates of plans of the leading technical schools of Europe. 7,000 w. Zeitschr d Oesterr Ing u Arch Ver.—Feb. 12 and 19, 1897. No. 11,722. 30 cts.

Technical Training in Germany. Information on some of the new schools from the report of a visit to Germany with a view of ascertaining the recent progress of technical education in that country. 2,700 w. Arch, Lond—Feb. 26, 1897. No. 11,527. 30 cts.

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Treatment of Water for Use in Hydraulic Elevators. M. O. Kasson. Recommends the plentiful use of soap to overcome evil effects of hardness of water. 700 w. Sta Eng—March, 1897. No. 11,492. 15 cts.

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The Transmission of Heat and Accompanying Phenomena. (Ueber Wärme Durchgang, und die darauf bezüglichen Versuchsergebnisse. Dr. Richard Mollier.) Experimental and mathematical investigation of the transmission of heat through various materials and under various conditions. Two valuable papers. 12,000 w. Zeitschr d Ver deutscher Ing. Feb. 6 and 13, 1897. No. 11,701. 60 cts.

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Details of a series of Precise Measurements with Steel Tapes. (Ueber eine Anreihevorrichtung für genauere Messungen mit dem Stahlbande.) An account of a series of experimental measurements to determine the probable error and limit of precision of steel tape measurements. An excellent paper with useful practical details. 3,500 w. Zeischr d Oesterr Ing u Arch Ver.—Feb. 12, 1897. No. 11,724. 30 cts.

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Mechanical and Technical Gossip. (Mechanische-technische Plaudereien.) A miscellaneous treatment of a number of mechanical problems, chiefly from a mathematical standpoint. Two articles. 7,500 w. Zeitsch d. Ver deutscher Ing.—Feb. 20 and 27, 1897. No. 11,707. 60 cts.

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The Microphonograph. (Le Microphonographe.) Illustrated description of Prof. Dussaud's combination of the microphone and phonograph for enabling deaf persons to train their hearing, also to furnish a means for most delicate auscultation, recording accurately by the normal or abnormal sounds of the body. 3,000 w. Le Génie Moderne—Feb. 15, 1897. No. 11,746. 30 cts.

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Amendments to the Patent Statutes. The old statutes and the new are given with editorial comment. 3,500 w. Sci Am—March 20, 1897. No. 11,668. 15 cts.

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Steam Pipe Work. W. S. Huyette. Part first briefly discusses materials and valves. 700 w. Heat & Ven—March 15, 1897. Serial. 1st part. No. 11,824. 15 cts.

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A Modern Power Plant. Edward J. Willis. Calls attention to the power-house of the Richmond Traction Co., Richmond, Va., showing the difficulties under which such plants sometimes operate, and how good results can be obtained in spite of unfavorable conditions. Ill. 2,000 w. Mach—April, 1897. No. 12,028. 15 cts.

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A New Unit of Work. (Ueber eine neue Arbeitseinheit.) It is suggested that a pressure of 1 atmosphere into a volume of 1 liter be called a liter atmosphere as a unit of work pv. Proposed by H. Lynen at the Aix-la-Chapelle branch meeting. 1,000 w. Zeitschr d Ver deutscher Ing—Feb. 20, 1897. No. 11,709. 30 cts.

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The Calorific Value of Certain Coals as Determined by the Mahler Calorimeter. N. W. Lord and F. Haas. Results of experiments conducted in the metallurgical laboratory of the Ohio State University to determine the calorific powers of coals in general use in Ohio, and how far ordinary analytical methods could be used as a basis for computing their values. 4,500 w. Trans Am Inst of Min Engs—March, 1897. No. 11,962. 45 cts.

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The Congo Coal Mine in Ohio. Description of the working of this noted mine, which is 60 miles southeast of Columbus. 1,100 w. Eng & Min Jour—March 13, 1897. No. 11,575. 15 cts.

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The Iron Industry of Belgium. M. Emile Harzie, in the Annales des Mines de Belgique. Gives information on iron mining, iron smelting, finished iron-making, steel production, steam engines and boilers, and coal consumption in mining and metallurgy. 1,000 w. Col Guard—March 5, 1897. No. 11,635. 30 cts.

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VENTILATION.

Contribution to the Study of Mine Ventilation. M. G. Hanarte, with explanations by J. W. P. Gives the Hanarte ar-

rangement of fan and its method of work. 2,500 w. Col Guard—March 12, 1897. Serial. 1st part. No. 11,833. 30 cts.

Notes on the Ventilation of Mines. T. A. Southern. A lecture delivered at University College, Nottingham. Part first discusses the pressure which produces ventilation; exhausting fans vs. forcing fans; upcast or downcast, which should be the larger, &c. 7,800 w. Col Guard—March 19,1897. Serial. 1st part. No. 11,-909. 30 cts.

VICTORIA.

State Aid to Mining in Victoria. C. C. Longridge. The article approves the action of the State in mining matters, explains ways in which the government have undertaken to assist capitalists, and discusses matters of interest. 1,000 w. Min Jour—Feb. 27, 1897. No. 11,594. 30 cts.

WATER.

Appliances for Winding Water. W. Galloway. Explains an instance in the experience of the writer where the water of a mine was raised by winding it to the surface up a vertical shaft. 1,000 w. Ir and Coal Trds Rev—Feb. 26, 1897. Serial. 1st part. No. 11,560. 30 cts.

MISCELLANY.

ALLOYS.

Alloys. W. C. Roberts-Austen. Abstract of the first of a new series of Cantor lectures. Describes methods of investigation. 1,000 w. Min Jour—March 20, 1897. No. 11,933. 30 cts.

ASBESTOS.

Asbestos Mining and Dressing at Thetford. H. Nelles Thompson. Conducted by quarrying. The methods are explained. 1,600 w. Can Min Rev—March, 1897. No. 12,039. 30 cts.

BRITISH COLUMBIA.

Notes on Some Mining Districts in British Columbia. John E. Hardman. Records facts and observations obtained during a trip in the summer of 1896. Touches briefly the geology, ore, production, &c., of the different districts. 5,000 w. Can Min Rev—March, 1897. No. 12,033. 30 cts.

COLORADO.

The Development of Colorado's Mining Industry. T. A. Rickard. Historical account. 5,000 w. Trans Am Inst of Min Engs—March, 1897. No. 11,970. 45 cts.

The Undeveloped Economic Resources of Colorado. Arthur Lakes. From Denver "News." Gives general geological section of the formations, and locates what each contains; includes ryolite lava, clays and coal, plastic clays, oil-bearing zone, limestone, sandstones and fire clay, gypsum, lithographic stone, marbles, granite, slate and onyx. Ill. 4,000 w. Stone—March, 1897. No. 11,659. 30 cts.

GALICIA.

The Mines of Galicia. Report on mines of gold, tin, copper, antimony, iron, coal, plumbago, asbestos and slate. 2,000 w. Cons Repts—March, 1897. No. 11,874. 45 cts.

GEMS.

Australian Gems. An account of the diamond field at Bingara, New South Wales, with information regarding other gems found in Australia. 1,800 w. Aust Min Stand—Feb. 11, 1897. No. 11,687. 30 cts.

MANGANESE Deposits.

The Manganese Deposits of the Department of Panamá, Republic of Colombia. Eduardo J. Chibas. Gives location, history, character of the ore, geological features, &c., with suggestions as to the origin. Ill. 4,300 w. Trans Am Inst of Min Engs—March, 1897. No. 11,966. 45 cts.

MINING Camp.

The Geology of a Typical Mining Camp in New Mexico. C. L. Herrick. Describes the Magdalena mountain range as illustrating many conditions of mineral accumulation and a variety of geological problems. 2,800 w. Am Geol—April, 1897. No. 11,985. 45 cts.

PICTOU Mines.

A Review of the Report of the Commission on Fires in Pictou Mines. H. S. Poole. Read before the Mining Soc. of Nova Scotia. An explanation and criticism of this report. 4,700 w. Can Min Rev—March, 1897. No. 12,034. 30 cts.

PLATINUM.

A Large Nugget of Platinum. Cyrus O. Baker. Interesting facts relative to the supply and consumption of this rare metal. Ill. 1,500 w. Elec Rev—March 24, 1897. No. 11,865. 15 cts.

SLATE.

Slate Production in the United States. James Hess. A review of the slate industry, the different localities, variaties, &c., with description of operation of slate quarries. 1,800 w. Yale Sci M—March, 1897. No. 11,685. 30 cts.

SOUTH AFRICA.

The Chartered Company in South Africa. John Mackenzie. Reviews the record of the company and criticises the policy and influence. 11,000 w. Contemporary Rev—March, 1897. No. 11,642. 45 cts.

TEMPERATURES.

Subterranean Temperatures at Wheeling, W. Va., and Pittsburg, Pa. W. Hallock. Observations taken from two remarkable wells of 4,500 feet and 5,386 feet in depth. Ill. 1,500 w. Sch of Mines Quar—Jan., 1897. No. 11,991. 45 cts.

TURQUOISE.

Turquoise Mining in Mexico. W. C. Fenderson. Refers to superstitions relating to this stone because of its change of color, and gives brief account of method of mining. 2,200 w. Min & Sci Pr—March 6, 1897. No. 11,539. 15 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACCIDENT.

The Accident to the Rope-Guarded Gasholder at Middlesbrough. Report relating to the recent accident to the rope-guided gasholder at the Corporation Gas Works. 2,000 w. Jour Gas Lgt—March 16, 1897. No. 11,944. 30 cts.

ACETYLENE.

Acetylene. A discussion of the properties, its dangerous qualities and advantages as an illuminant. 1,200 w. Fire and Water—March 6, 1897. No. 11,478. 15 cts.

A German Conference on Acetylene. A summary, compiled from the Journal für Gasbeleuchtung" of the conference proceedings of the German Society of Chem, Ind., giving the precautions considered necessary. 1,500 w. Jour Gas Lgt—March 23, 1897. No. 11,999. 30 cts.

Automatic Generators of Acetylene (Générateurs Automatiques d'Acetylene.) Illustrated description of improved Acetylene Generator; also Acetylene for Generating the Gas as needed for immediate use. 1,000 w. La Génie Moderne. Feb., 15, 1897. No. 11,745.

Report upon Acetylene Gas (Bericht über den corporativen Besuch des von der Acteylengas-Gesellschaft Demonstration). A report of the visit of a committee of the Society of Austrian Engineers to an exhibition of Acetylene Gas. With illustrations of Generators, &c. 2,500 w. Zeitsch. d. Oesterr. Ing. u. Arch. Ver.—Feb., 26, 1897. No. 11,734.

AMMONIA.

Does the Manufacture of Sulphate of Ammonia pay in Small Works? J. Wilkinson, read before the Manchester Dist. Inst. of Gas Engs. Discusses the subject, concluding that the intermittent still is the most efficient method to adopt at small gas works. Duscussion. 4,000 w. Jour Gas Lgt—March 2, 1897. No. 11,578. 30 cts.

ANALYSIS.

A Technical Analysis of Hydrocarbon, Vapor and Gasses in Literature and Laboratory. Dr. W. H. Birchmare. Part first, consists of an examination of methods and published work in this field, and will be followed by personal work of the writer. 2,500 w. Am Gas Lgt Jour—March 22, 1897. Serial, 1st part. No. 11,844. 15 cts.

BELFAST.

Cost of Illuminating Gas in Belfast. Consular report on the cost of the material and labor required for the manufacture of gas ready for consumption. The price to consumers is 60 cents per 1,000 cubic feet. 500w. Con Repts—April, 1897. No. 11,919. 45 cts.

CALORIMETRY.

Calorimetry. C. D. Jenkins. Brief account of investigations with short discussion. 1,200 w. Am Gas Lgt Jour—March 22, 1897. No. 11,842. 15 cts.

CARBIDE of Calcium.

Restrictions Placed on Carbide of Calcium in England. Notification issued by the English Home Office regarding the keeping of Carbide of Calcium. 700 w. Pro Age—April 1, 1897. No. 11,982. 15 cts.

COKE Ovens.

Some Remarks on Coke Ovens and Their Products. S. J. Fowler. Description of the Semet Solvay Oven, located at the works of the Solvay Process Co., in Syracuse, N. Y., with drawing. The illuminating coal gas plant and the retort Coke Oven plants are compared, and related matters examined. Discussion follows. 4,000 w. Am Gas Lgt Jour—March 8, 1897. No. 11,481. 15 cts.

FLAMES.

The Source of Light in Flames. Arthur Smithells. Report of a lecture at the Royal Inst. A study of the flames of various gases. 2,200 w. Gas Wld—March 20, 1897. No. 11,937. 30 cts.

FLOW.

The Flow of Gas or Steam Through Pipes. Arthur J. Martin. Table of the flow of gas or steam through pipes, with an examination of some of the formulae now in use. 2,500 w. Engng.—March 19, 1897. No. 11,903. 30 cts.

GAS.

Some Comparisons of Gas Making, from 1853 to December, 1896, and Some of the Writer's Experiences at the Small Gas Works at Fitchburg. The paper is almost entirely devoted to gas-making in Fitchburg, and is followed by short discussion. 2,[illegible] w. Am Gas Lgt Jour—March 22, 1897. No. 11,843. 15 cts.

GAS Distribution.

Gas Distribution. William H. Snow. Read before the New England Assn. of Gas Engs. Refers to pipes, cocks, gates, naphthaline, &c., and is followed by discussion. 5,800 w. Am Gas Lgt Jour—March 8, 1897. No. 11,479. 15 cts.

GAS Industry.

Inaugural Address of Robert Porter. Reviews progress during the present reign, with comparison of the advantages of carburetted water- gas with coal-gas. 4,000 w. Jour Gas Lgt—March 2, 1897. No. 11,577. 30 cts.

LEAKS.

Reports of Gas Leaks. Their Management by a Large Company. W. R. Ad-

dicks. A statement of the system adopted in Boston, considering their management, when they occur, and the methods adopted to prevent their occurrence. Discussion follows. 7,500 w. Am Gas Lgt Jour—March 22, 1897. No. 11,841. 15 cts.

MEASUREMENT.

Measurement of Gas. C. W. Hinman. Read be.ore the New England Assn. of Gas Engineers. Consisting the apparatus used for measuring the requisites of gas meters, diphragms, capacity, &c., with discussion. 4,800 w. Am Gas Lgt Jour—March 15, 1897. No. 11,591. 15 cts.

MINERAL Oils.

Determining the Gas-Making Value of Mineral Oils. Dr. F. Helfers. Abstract translation from the "Zeitschrift fuer Angewandte Chemie. Results of thests made by the use of Wernecke's Laboratory Gas-Making Apparatus, which gives correct results from the gasification of 1.4 oz. of oil. 1,300 w. Jour Gas Lgt—March 23, 1897. No. 12,000. 30 cts.

OIL.

The Application of Oil for the Production of Illuminating Gas. C. Hunt. Read before the Midland Assn of Gas Managers. Gives brief instorical review, extant processes, effect of temperature, the Peebles process, &c. 4,500 w. Gas Wld—Feb., 27, 1897. No. 11,529. 30 cts.

PURIFICATION.

The Use of Atmospheric Air with Lime for the Purification of Coal Gas. S. Carpenter. Remarks from the writer's experience. 800 w. Jour of Gas Lgt—March 9, 1897. No. 11,686. 30 cts.

TEMPERATURE.

The Effect of Temperature upon Gas. W. E. McKay. Read before the New England Assn. of Gas Engs. Gives table for carburetted water-gas saturated with aqueous vapor, no other vapors being present, showing the changes made by change of temperature, with discussion of the subject by the writer and members. 8,400 w. Am Gas Lgt Jour—March 8, 1897. No. 11,480. 15 cts.

WATER Gas.

Carburetted Water Gas. J. T. Wastcott. A paper read before the Civil and Mech. Engs. Ass., given in abstract. Reviews the processes now in successful use, describes the combined type. 1,800 w. Gas Wld—March 20, 1897. No. 11,938. 30 cts.

Inaugural Address of Mr. John Young, before the Midland Association of Gas Managers. The address is largely confined to experiences in Hanley. Carburetted water gas, naphthalene deposits, and other subjects of interest are discussed. 6,000 w. Gas Wld—Feb., 27, 1897. No. 11,528. 30 cts.

SEWERAGE.

ASSESSMENTS.

Sewer Assessments. F. Herbert Snow. Discusses the fundamental object of assessment, the frontage plan, area plan, frontage and area combined, entrance fee plan, valuation, rental, Brocton plans, &c. Followed by discussion and reports from various cities of Mass. 2,500 w. Jour Assn of Engng Soc—Jan., 1897. No. 11,785. 30 cts.

FILTRATION.

Denny and Duniface Sewage Filtration Works. Drawings and photograph of these sewage filtration works, with description. The whole of the sewage is treated by intermittent downward filtration. 700 w. Eng, Lond—March 12, 1897. No. 11,819. 30 cts.

The Operation of the Pawtucket, R. I., Sewage Filter Beds. Information of the successful operation of sand filters. 700 w. Eng Rec—March 6, 1897. No. 11,458. 15 cts.

INCINERATION.

The Incineration of the Sewage of Paris. (L' Incineration des Gadoues de Paris.) A discussion of the various processes for incinerating solid refuse, with especial reference to the introduction of such apparatus into Paris. Descriptions of the Oldham, Javel and Horsfall furnaces. 3,000 w. La Revue Technique—Feb. 25, 1897. No. 11,752. 30 cts.

PURIFICATION.

The Purification of Sewage and Water. W. J. Dibdin. It is proposed in this series of articles to place on record the results arrived at in the personal experience of the writer. The purification of the river Thames revealed facts which established principles that have been adopted generally. The subject will be fully dealt with and the practical application considered. 4,000 w. San Rec—March 5, 1897. Serial, 1st part. No. 11,627. 30 cts.

RIVER Pollution.

Report of the Passaic Valley Sewerage Commission. Gives recommendations of the Commission to remedy thè pollution of this stream. Also editorial comment. 2,200 w. Eng News—March 11, 1897. No. 11,547. 15 cts.

SALT LAKE CITY.

Outfall Sewer and Sewage Farm at Salt Lake City, Utah. Illustrated description of the gravity intercepting sewer and the sewage farm, which were undertaken to prevent the pollution of the Jordan River. 1,500 w. Eng News—March 18, 1897. No. 11,792. 15 cts.

SEWAGE Disposal.

Sewage Disposal. W. M. Watson. An examination of some of the systems for cleansing sewage and their inefficiency; claiming that no chemical process, without some secondary treatment, is capable of producing a sufficiently pure effluent. Ill. 2,000 w. Can, Eng—March, 1897. No. 11,570. 15 cts.

Handling Boston's Sewage. Henry G.

Young. Extracts from a lecture before the Massachusetts Assn. No. 1, N. A. S. E. The growth of the system in Boston and the steam plant necessary to handle it. 1,800 w. Bos. Jour of Com—March 27, 1897. No. 1,922. 15 cts.

The Utilization of Town Sewage. Alderman Maskery. A paper read in relation to the Peat system of town refuse utilization as adopted at Congleton. 2,500 w. San Rec—March 19, 1897. No. 11,923. 30 cts.

SEWERAGE.

New Sewerage of the City of Melbourne. Report of the Consul-General to the State Dept. Describes the conditions to be met and the work as planned. 3,400 w. San—March, 1897. No. 11,490. 45 cts.

SEWERS.

Concrete Monolithic Sewers of Wilmington, Del. T. Chalkley Hatton. Illustrated description. 1,500 w. Eng. Rec—March 6, 1897. No. 11,456. 15 cts.

Sewers for Small Cities. Alfred E. Phillips. Considers some general propositions applicable to all cases, that should be given weight in planning a system, with hints as to the best method of carrying out the work. 4,300 w. Wis Eng—Jan., 1897. No. 11,853. 45 cts.

STREETS AND PAVEMENTS.

BRICK.

A new Testing Machine and the Cross-Breaking Test of Vitrified Paving Brick. F. F. Harrington. Describes the testing machine designed by M. L. Holman and gives the results of an investigation of the cross-breaking test of paving brick. Ill. 4,000 w. Jour Assn of Engng Soc—Jan. 1897. No. 11,786. 30 cts.

Standard tests for Paving Brick. Almon D. Thompson. Exceptions to conclusions reached by the committee of the Nat Brick Mfr Assn. 1,700 w. Munic Engng—April, 1897. No. 11,995. 30 cts.

Supplemental Specifications by the Paving Brick Commission. Supplemental to the report of the commission heretofore published. Specifications for tests with table. 1,400 w. Munic Engng— April, 1897. No. 11,996. 30 cts.

PAVING.

Granite-Asphalt. (Le Granite-Asphalte.) A combination of asphalt and crushed granite, furnishing a paving having all the advantages of asphalt, without its slipperiness. 1,200 w. Le Génie Moderne—Feb. 15, 1897. No. 11,744. 30 cts.

ROAD Making.

Tests of Resistance of Vehicles on Common Roads by the U. S. Department of Agriculture. Report of a series of experiments to determine the value of tractive force in the case of vehicles and roads now in use. 1,300 w. Eng News—March 18, 1897. No. 11,791. 15 cts.

STREET Cleaning.

Street Cleaning in Paris and Berlin. Robert Grimshaw. Describing plants, personnel and methods of European street cleaning department. 3,800 w. Eng Mag—April, 1897. No. 12,054. 30 cts.

VIENNA.

Street Improvements in the City of Vienna. (Ueber die Reguliring der innern Stadt von Wien.) A plan submitted by Architect Lotz for the improvement of the central portion of Vienna by cutting new streets and widening old ones. An excellent study in municipal improvement. 1,500 w. and map. Zeitschr d Oesterr Ing u Arch Ver—Feb. 19, 1897. No. 11,727. 30 cts.

WOOD Paving.

Hardwood Pavements in Sydney, New South Wales. R. W. Richards. Abstract of paper read before the English Assn. of Munic. and Co. Engs. on the latest experience with hardwood pavements in Sydney. Favorable to its use. 1,000 w. Eng News—March 18, 1897. No. 11,794. 15 cts.

A Hygenic View of Wood Paving. Translated for Hardwood from L'Echo Forestier. A. Petsch. Thinks wood paving has not interfered with sanitary conditions. 900 w. Sci Am Sup. March 20, 1897. No. 11,672. 15 cts.

Maintenance of Wood Pavement in Europea n Cities. Robert Grimshaw. Brief reports from London, Paris and Germany. 500 w. Munic Engng—April, 1897. No. 11,994. 30 cts.

WATER SUPPLY.

BROOKLYN.

The report of the Manufacturers' Associaton of Kings and Queens Counties on the Brooklyn Water Supply. Abstract of report dealing with the future and immediate needs of the city, advocating the use of meters, the establishment of a permanent analytical laboratory, and recommendations for increasing the supply. Also editorial. 1,400 w. Eng Rec—March 27, 1897. No. 11,898. 15 cts.

CAMBRIDGE, Mass.

Water-Works of Cambridge, Mass. Illustrated description of the works, which are being extensively enlarged, so as to increase the supply, pressure and pumping capacity. 1,800 w. Fire and Water—March 20, 1897. No. 11,845. 15 cts.

CONCORD, N. H.

Concord, N. H. Water Department. Illustrated description of a plant that has been in use about four years and is satisfactory in every respect. 1,200 w. Fire and Water—March 13, 1897. No. 11,651. 15 cts.

HUNGARY.

Arad Water-Works, Hungary. Illustration and brief description, with table giving the return of the filters for Oct., 1895. 800 w. Ind Engng—Jan. 30, 1897. No. 11,464. 45 cts.

METERS.

The progress of Water Meterage. Part first calls attention to the rapid progress made in the introduction of meters and gives report from Harrisburg. 1,200 w. Fire and Water—March 6, 1897. Serial, 1st part. No. 11,477. 15 cts.

NEW YORK.

The Future Water Supply of New York. An interview with Gen. Duane, President of the Croton Aqueduct Commission. 1,000 w. Fire and aWter—March 20, 1897. No. 11,846. 15 cts.

RESERVOIR.

The Repairs to the Queen Lane Reservoir, Philadelphia, Pa. Gives investigations made to determine the power of asphalt to resist percolation of water, as some of the work failed to give satisfaction. 1,300 w. Eng Rec—March 27, 1897. No. 11,899. 15 cts.

TORONTO.

Water Supply of Toronto, Ont. An account of the cost of the water supply works, now owned by the city, and of an accident causing the breakage of a five-foot and a four-foot pipe. Ill. 1,000 w. Fire and Water—March 27, 1897. No. 11,924. 15 cts.

WATER Supplies.

See Civil Engineering, Irrigation.

WATER Works.

Valuation of Water-Works Property. Wynkoop Kiersted. Discusses the determining power of water-works property. The difference between cost and value; the various methods of valuation, &c. 7,000 w. Pro Am Soc of Civ Engs—March 1897. No. 11,882. 75 cts.

MISCELLANY.

GARBAGE.

The Garbage-Disposal System of New Brighton, N. Y. Information relating to the Brownlee crematory in use on Staten Island. 900 w. Eng Rec—March 13, 1897. No. 11,639. 15 cts.

MUNICIPAL Lighting.

See same title under Electrical Engineering—Lighting.

PAINT.

The Painter as a Sanitarian. John Dewar. Calls attention to the impurities that accumulate on the walls and ceiling, and the use of paint in restoring a more healthful condition than is possible in papered rooms. 1,600 w. Plumb & Dec—March 1, 1897. No. 11,585. 30 cts.

PUBLIC Work.

Public Work and How to Do It. I. A Boston Argument in Favor of Direct Municipal Performance. Sylvester Baxter. II. Toronto and Chicago Compared in the Matter of Street-Cleaning by Contract. George E. Hooker. Part 1st presents the evils of the contract system, with comparative costs of public and private contract, etc. Part 2d gives highest praise to the direct labor system of Toronto and severely criticises the contract system in Chicago. Ill. 4,500 w. Rev of Rev—April, 1897. No. 11,998. 30 cts.

PUMPING.

Comparative Cost of Steam and Electric Pumping in New Orleans, La. The results of a study detailed estimates which have led B. M. Harrod, chief engineer of the Drainage Commission, to report in favor of a central power station with electrical transmission in carrying out a drainage scheme for this city. 1,000 w. Eng Rec—March 20, 1897. No. 11,803. 15 cts.

PURIFICATION.

See same title under Municipal Engineering—Sewerage.

SANITATION.

European Sanitary Engineering. James H. Fuertes. Describes the arrangement and operation of the refuse-disposal plant at Cambridge, Eng. Ill. 1,300 w. Eng Rec—March 20, 1897. Serial. 1st part. No. 11,804. 15 cts.

The Evolution of Sanitation in Relation to the Plumber. John Glaister. Extract from a paper read in Edinburgh. Calls attention to the problems that arose in the evolution of man from the barbaric to the civilized state, and to the main points to be attended to in sanitary plumbing. 2,000 w. Plumb & Dec—March 1, 1897. Serial. 1st part. No. 11,584. 30 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

CONSTRUCTION.

Mistakes and Improvements in Railroad Construction. George H. Paine. Showing that the tendency in maintenance of way work is towards more subsoil tile drains, abundance of good stone ballast and immovability of track (Ill). 4,500 w. Second paper. Eng'ng Mag—April, 1897. No. 12,050. 30 cts.

EAST Coast.

The Lancashire, Derbyshire and East Coast Railway. Illustrated description of the line and some of the constructive works, with information concerning the road. 2,200 w. Eng Lond—March 12, 1897. No. 11,820. 30 cts.

EGYPT.

Railway Development in Egypt. Information from the report of Lord Cromer, relating to railway extension. 1,700 w. Trans—Feb. 26, 1897. No. 11,524. 30 cts.

GAGE.

Fixed Point on the Mixed Gage. J. E.

A suggestion to overcome difficulties arising from the use of the mixed gage. Ill. 1,800 w. Ind Eng'ng—Feb. 18, 1897. No. 11,814. 45 cts.

GREAT Western Ry.

The Progress of the Great Western Railway. An account of the schemes and projects by which a great improvement in the traffic is to be accomplished. 3,300 w. Eng Lond—March 12, 1897. No. 11,818. 30 cts.

KOREA.

Railroads in Korea. J. Henry Dye. Information concerning the prospects for railroad building, and the various lines under consideration. 3,500 w. RR Gaz—March 12, 1897. No. 11,555. 15 cts.

TRACK.

Track Elevation at Brockton, Mass; N. Y. N. H. & H. R. R. Illustrated description of an interesting example of work. 1,200 w. Eng News—March 25, 1897. No. 11,876. 15 cts.

TRACKS.

Depression of the Tracks of the Boston & Albany RR., at Newton, Mass. Illustrated description of the depression of the four-track line of the Boston & Albany, below the normal surface of the ground. 900 w. Eng News—March 18, 1897. No. 11,790. 15 cts.

MAINTENANCE OF EQUIPMENT.

AXLES.

Revolution-Testing Machine for Axle Material—Pennsylvania Railroad. Describes and illustrates an interesting device for testing the effect of reversal of stress upon metals designed for the purpose of determining the behavior of material used for axles, when subjected to rapidly repeated alternating strains. 8,000 w. Ry Mas Mech—March, 1897. No. 11,461. 15 cts.

BOLSTERS.

Finding the Stresses in Trussed Bolsters. Explanation of the graphical method, with diagrams, showing how clearly this method brings out the result of the combination of various assumptions. 1,000 w. Ry Mas Mech—March, 1897. No. 11,460. 15 cts.

CAR.

Standard Twin-Hopper Gondola Car—New York Central and Hudson River Railroad. Illustrated description of a car considered the proper thing for the coal traffic of one of the most important systems. 800 w. Loc Engng—March, 1897. No. 11,463. 30 cts.

Steel Hopper Car of 100,000 Lbs. Capacity—Pittsburg, Bessemer and Lake Erie Railroad. Illustrated description of car especially intended to carry ore from the Lake Erie terminal to Pittsburg. 2,500 w. RR Car Jour—March, 1897. No. 11,-540. 15 cts.

COAL.

Efficiency of Coal Consumption in Railway Practice. Herbert Wallis. Extract from the president's address at the meeting of the Cannadian Soc of Civ Engs. Some facts about fuel in its relation to locomotive steam practice, especially coal. 2,200 w. Can Eng—March, 1897. Serial, 1st part. No. 11,566. 15 cts.

COUPLER.

Some of the Curiosities of the Car-Coupler. Illustrated description of 2o couplers out of the 6,500 forms in the Patent Office. None of those shown have been really used. 1,600 w. RR Gaz.—March 12, 1897. No. 11,559. 15 cts.

CRADLES.

Rolling Cradles for Light Railways. C. S. Du Riche Preller. Results of the writer's inspection of several typical rolling-cradle installations, notably in Southern Germany and Switzerland. Ill. 3,500 w. Engng—March 19, 1897. No. 11,904. 30 cts.

HEADLIGHT.

The Pyle National Electric Headlight. Illustrated description of the essential features. 1,000 w. RR Gaz—March 12, 1897. No. 11,554. 15 cts.

LOCOMOTIVES.

Corliss Valve Gear for Locomotive Engines. M. E. Polonceau. Notes and summarized translation from Les Annuales des Mines. The writer has made use of a system of four Corliss valves for locomotives. This system is explained and its advantages stated. 2,000 w. Engng—Feb 26, 1897. No. 11,504. 30 cts.

Details of Eight-Wheel Locomotive—Illinois Central Railroad. Illustrated detailed description, with sections, plan and elevations of frames. 900 w. Ry Rev—March 13, 1897. Serial, 1st part. No. 11,-665. 15 cts.

Details of the Compound Mastodon Locomotives for the Northern Pacific Railroad. Detail drawings, with description. 2,000 w. Am Eng & RR Jour—April, 1897. No. 12,001. 30 cts.

Early Engines of Stephenson and Company. Clement S. Stretton. Historical account, with illustrations and list of engines built from 1824 to 1833. 1,200 w. Ry Wld—March, 1897. No. 11,603. 30 cts.

European Locomotive Frames. Robert Grimshaw. Illustrated description of frames used in European locomotive practice. 1,000 w. Ry Mag—Feb, 1897. No. 11,472. 30 cts.

Standard South-Western Locomotives. Illustrated detailed description. 1,500 w. Ry Wld—March, 1897. No. 11,600. 30 cts.

The Hagans Locomotive Engine. (Hagans Locomotive.) (An illustrated description of a new type of eight-driver locomotive, without trucks and with flexible wheel base. 1,500 w.) Glaser's Annalen—Feb. 15, 1897. No. 11,715. 30 cts.

LOCOMOTIVE Performance.

Some Questions of Locomotive Per-

formance. Summary of editorial in the Engineer, London, with reply from Mr. Vawclain. 3,000 w. RR Gaz—March 19, 1897. No. 11,692. 15 cts.

PAINTING.

Painting Freight Cars by Compressed Air. Charles E. Copp. Abstract of a report read at meeting of New England RR Club, the result of a visit to Pittsburg for the purpose of investigating the subject. 1,000 w. RR Car Jour.—March, 1897. No. 11,542. 15 cts.

Pneumatic Painting Criticized. Gives reason for objecting to this method of painting. 900 w. RR Car Jour.—March, 1897. No. 11,541. 15 cts.

ROCKET.

George Stephenson's Rocket. A historical difficulty explained. Ill. 600 w. Sci Am Sup—March 13, 1897. No. 11,536. 15 cts.

SWIVEL Truck.

The Action of the Krauss Swivel Truck on Curves (Die Einstellung des Krauss-'schen Drehgestelles in Krümmungen. Von Borries.) An examination of the unequal rail pressure of swivel trucks upon curves of different radii. 1,000 w. Glaser's Annalen—Feb. 15, 1897. No. 11,716. 30 cts .

VALVES.

The Schenectady Intercepting and Exhaust Valves. Engravings, with description of the intercepting compound locomotives, as designed by Mr. Pitkni and Mr. Sague for the Northern Pacific twelve-wheeler. 1,000 w. RR Gaz.—March 26, 1897. No. 11,887. 15 cts.

MAINTENANCE OF WAY.

BRIDGE Extension.

See same title under Civil Engineering —Bridges.

BRIDGES.

Standard Specifications for Metal Bridges, Boston and Maine RR. An abstract of some of the more novel features of these specifications. 1,100 w. Eng News—March 18, 1897. No. 11,796. 15 cts.

CURVES.

Adjustment Curves William G. Raymond. From a forthcoming text-book, "The Elements of Railroad Engineering." The theory and practice of curves in railroading. Treats of the two general methods of providing for gradual entry to a curve. 1. The three-centre compound curve. 2. The transition curve, or spiral. 4,500 w. Polytechnic—March 27, 1897. No. 11,946. 15 cts.

The Elevation of the Outer Rail of Railway Curves. Wm. G. Raymond. Abstract of a paper in the last issue of "The Polytechnic" discussing the proper amount of cant to give railway track on curves. 700 w. Eng News—March 25, 1897. No. 11,878. 15 cts.

STATION.

A Handsome Structure for Galveston. Illustrated description of a new depot and general office building for the Gulf, Colorado and Santa Fe. 1,000 w. Ry Age—March 5, 1897. No. 11,482. 15 cts.

Van Buren Street Suburban Station—Illinois Central RR., Chicago. Illustrated description. 700 w. Ry Rev—March 6, 1897. No. 11,502. 15 cts.

TIES.

Cedar Ties in Service. Moses Burpee. A study of the character of the wood, reasons for its failure under certain conditions, its weak points and redeeming qualities. Ill. 3,700 w. Ry Rev—March 13, 1897. No. 11,664. 15 cts.

TIMBER.

See same title under Civil Engineering —Miscellany.

TRACKS.

Undulations in Railway Tracks. P. H. Dudley. A study of the deflections of rails, the causes and remedy; the objects of permanent way construction and the success attained between New York and Buffalo, on the N. Y. C. and H. R. RR. Ill. 5,400 w. Sch of Mines Quar—Jan., 1897. No. 11,989. 45 cts.

TURNTABLES.

Some Examples of Recent Practice in Turntable Design. An examination in a general way of some of the theoretical and practical considerations which enter into turntable design and construction, with a study of the particular designs illustrated in the present number. 3,500 w. Eng News—April 1, 1897. Serial, 1st part. No. 11,705. 15 cts.

SIGNALING.

CROSSINGS.

Crossing Protection Between Electric and Steam Railways. Extract from advance sheet of report of the Railroad Commissioners of Massachusetts. A statement of dangerous conditions, with suggested remedies. 1,000 w. Ry Rev—March 27, 1897. No. 11,953. 15 cts.

ELECTRO-PNEUMATIC.

Electro-pneumatic Contact System. (Pneumatisch-elektrischer Kontakt-Apparat.) Illustrated description of the Boldt & Vogel automatic signal. An electric contact, made by the elastic depression of the rail, operates the valve of a pneumatic system of signals and switches. 2,000 w. Glaser's Annalen—March 1, 1897. No. 11,719. 30 cts.

INTERLOCKING.

Two New Interlocking Plants. Illustrated description of two plants recently installed. One at Germantown Junction, Philadelphia and Reading RR., the other at Seattle, Wash., Great Northern Ry. 800 w. Eng News—March 11, 1897. No. 11,543. 15 cts.

SIGNALLING.

Some Signal Problems. H. M. Sperry. Read before the Railway Signalling Club, Chicago. Considers some of the prob-

lems that have not yet been satisfactorily solved, such as colors for night signals, a method of checking the operation of distant signals, &c. 2,300 w. RR Gaz—March 19, 1897. No. 11,693. 15 cts.

TRANSPORTATION.

ACCIDENTS.

Train Accidents in the United States in February. Report of accidents of the month, with classified summary. 2,000 w. RR Gaz—March 26, 1897. No. 11,886. 15 cts.

COMPETITION.

Railway Rivalry in Scotland. A statement of the competitive schemes and difficulties affecting the railroads of Scotland. 2,000 w. Engng—March 19, 1897. No. 11,907. 30 cts.

Suburban Competition. Charles J. Bates. Considers the requirements of a system that will enable lines to compete successfully with electric lines in handling traffic. 1,600 w. RR Gaz—March 12, 1897. No. 11,553. 15 cts.

EARNINGS.

Improving Railway Earnings. Tables of gross earnings in Feb. 2,000 w. Bradstreet's—March 13, 1897. No. 11,565. 15 cts.

ELECTRICITY.

Electricity on Steam Roads. Extracted from the address of Charles P. Clark before the Railroad Committee of Connecticut. Gives an account of the experiments near Boston, the successful use of the third rail system and a general discussion of the problem. 2,800 w. St Ry Rev—March 15, 1897. No. 11,612. 30 cts.

FAST Running.

Remarkable Running Achievements by Scottish Railway Companies. Record of work on the North British and Caledonian railways. 1,200 w. Trans—March 19, 1897. No. 11,934. 30 cts.

FREIGHT Rate.

An English Freight Rate Adjustment. Editorial discussion of the decision reached in a case brought before the Commission relating to an increase of 2½ per cent. on coal traffic carried to London. 1,200 w. RR Gaz—March 12, 1897. No. 11,557. 15 cts.

The Eau Claire Lumber Rate Case Editorial Examination of the controversy relating to the transportation of lumber. 1,200 w. RR Gaz—March 12, 1897. No. 11,556. 15 cts.

The Grain Rate Differentials. A discussion of the case before the Interstate Commerce Commission. The complaint that the trunk railroads make rates from the West to the seaboard cities that unjustly discriminate against New York to the benefit of other cities. A statistical table relating to flour, wheat and corn receipts and exports is given. 1,600 w. Bradstreet's—March 20, 1897. No. 11,788. 15 cts.

Hearing on New York Grain Rates. A summary of the New York argument made by John D. Kernan, with testimony of several witnesses and editorial. 3,500 w. RR Gaz—March 26, 1897. No. 11,884. 15 cts.

"LIGHTING Trains."

"Lightning Trains" on the North British Railway. Charles Rous-Martin. Detailed account of test journeys two and fro between Edinburgh and Berwick, with a diagram showing the gradient profile of the section of the line on which the running took place. 3,300 w. Eng, Lond—March 12, 1897. No. 11,817. 30 cts.

POOLING.

The Pooling of Railway Earnings. Aldace F. Walker. The differences which exist between railways and other business enterprises in the matter of determining the charges to be made are shown, the object of the railway pool explained and the method suggested for meeting the requirements of the present situation in the United States. 4,000 w. Ry Mag—Feb. 1897. No. 11,470. 30 cts.

A Pooling Law Before Congress. Discusses the bill introduced in the United States Congress by Senator Foraker, of Ohio, aiming to formulate a measure which will authorize agreements to maintain reasonable rates. 1,000 w. No. 12,009. 15 cts.

Full Text of the Trans-Missouri Freight Association Decision. 19,500 w. Ry Age—March 26, 1897. No. 11,939. 15 cts.

SPEED.

The Limits of Speed and Frequency of Trains in Tunnels. The consideration of a problem presented at meeting of N. Y. RR. Club, and left unanswered, as to the safety of running trains at 30 miles an hour, on one minute headway, through a tunnel with grades as stated. 1,200 w. RR Gaz—March 26, 1897. No. 11,888. 15 cts.

Some Studies in Speed and Accelerations of Various Motors. George L. Fowler. Investigations of the mechanical possibilities of the several methods of passenger transportation that are at present in use in the neighborhood of New York City. 3,800 w. RR Gaz—March 19, 1897. Serial. 1st part. No. 11,694. 15 cts.

MISCELLANY.

AVALANCHE.

The Avalanche at Ophie. An account of the snowslide which overwhelmed the Rio Grande Southern depot and tracks, with illustrations. 1,100 w. Ry Age—March19, 1897. No. 11,850. 15 cts.

BRITISH Railroads.

British Railroad Matters. W. M. Ac-

worth. Treats briefly of light railroads, railroad clubs, and of a new through service between London and Paris. 1,200 w. R R Gaz—March 12, 1897. No. 11,551. 15 cts

British Railways in 1896. William J. Stevens. A survey of the year's railway working and results, confined mainly to the principal English and Welsh companies. 4,200 w. Bankers' Mag, Lond—March, 1897. No. 11,563. 30 cts.

COLLISION.

See same title under Street and Electric Railways—Miscellany.

DENMARK.

Danish State Railroads. Comments on the published statistics of the past year. 700 w. R R Gaz—March 12, 1897. No. 11,558. 15 cts.

DISCIPLINE.

One Year's Experience with the Brown System of Discipline. H. S. Rearden. The Chicago, Peoria & St. Louis Railroad Co. adopted this system on Feb. 1, 1896. The success of the past year is recorded and the advantages explained. 4,800 w. Ry Mag—Feb., 1897. No. 11,471. 30 cts.

ELECTRICITY.

Electricity on the Cincinnati Southern Railway. Stephen L. Coles. Describes electric signals, lights, headlights and various devices in use on this road. Ill. 2,400 w. Elec Rev—March 10, 1897. No. 11,493. 15 cts.

EMPLOYEES.

Relations Between Railways and Their Employees. Report of a special committee of the Am. Soc. of Ry. Supts. Includes the selection of employees, discipline, systems of relief, &c. 1,500 w. Ry Rev—March 20, 1897. No. 11,851. 15 cts.

INDIA.

Railway Travel in India. Allan Forman. An account of travel in this country which indicates very comfortable accommodations; also some reference to interesting sights. 1,400 w. Ry Age—March 12, 1897. No. 11,631. 15 cts.

STRIKE.

See "The Collapse of the Northeastern Strike," under Economics and Industry—Labor.

TUNNEL.

See same title under Civil Engineering—Miscellany.

TUNNEL Ventilation.

Ventilation Difficulties in the Arlberg Tunnel. Abstract from an article in "Revue Generale des Chemins de Fer." Trouble from the use of coal and coke were largely overcome by the use of petroleum for steam producing. 1,100 w. Eng News—March 18, 1897. No. 11,795. 15 cts.

STREET AND ELECTRIC RAILWAYS.

AIR Cars.

Cost of operating Air Cars in New York City. Edward E. Pettee. A statement of the actual operating expenses for seven months, through extreme ranges of temperature. Ill. 2,300 w. Com Air—March, 1897. No. 11,993. 15 cts.

BRAKES.

Brake Rigging for Electric Cars. C. F. Uebelacker. Calls attention to some of the more prominent conditions which brake rigging in general must meet. Ill. 3,500 w. St Ry Jour—March, 1897. No. 11,698. 45 cts.

CABLE.

System of Cable Traction, Mollard & Dplac (Systeme de Remorguage Funiculaire, Mollard et Dulac). A combined cable and electric trolley system, by means of which electric cars carry a grip and are hauled up steep inclines by continuous running cable. 7,000 w. La Revue Technique—Feb. 25, 1897. No. 11,753. 30 cts.

CAR Lighting.

See same title under Electrical Engineering, Lighting.

COLLISION.

Report on a Grade Crossing. Collision Between a Railway Train and an Electric Car. Account of accident taken from an advance copy of the report on Street Railways, issued by the Board of RR Commissioners of Massachusetts. The collision was in the town of Somerset. The electric car was demolished and the train derailed. 2,400 w. Eng News—March 11, 1897. No. 11,545. 15 cts.

CONSTRUCTION.

The Columbia and Maryland Railway. S. W. Huff. A sketch of some of the plans and problems encountered in the construction of this railway. Part first states the conditions to met, and the special form of three-wire system used. Ill. 1,900 w. St Ry Rev—March 15, 1897. No. 11,614. 30 cts.

CURVES.

Dead Man's Curve. A discussion of means to overcome the danger at the corner of Fourteenth st. and Broadway, New York. Recommends the changing of motive power from cable to electricity. 1,000 w. Elec Wld—March 6, 1897. No. 11,500. 15 cts.

ELEVATED Railway.

A new form of Elevated Railway Construction (Ein Neues Hochbahn System.) This appears to be practically the well-known "bicycle" system, with single rail below and guide rail above, revived in Geremany. 1,000 w. Zeitsch d Oesterr. Ing u Arch Ver—March 5, 1897. No. 11,736. 30 cts.

GEARS.

The Life of ears. H. S. Cooper. Reasons for the determination to use only a rawhide pinion and a metal gear. 1,500 w. St Ry Jour—March, 1897. No. 11,776. 45 cts.

GERMANY.

Electric Street Railways (Elektrische Strassenbahnen. Dr. Gustav Rasch). A discussion of general principles of installation, including the combined overhead and underground system, together with the use of storage batteries. 5,000 w. Zeitschr d Ver Deutscher Ing—Feb. 6, 1897. No. 11,702. 30 cts.

JUNGFRAU.

The Jungfrau Railway. Brief account of this unique railway, with perspective view, profile and geological section. 1,800 w. Ry Wld—March, 1897. No. 11,602. 30 cts.

MAIL Service.

Mail Service on Street Railways. Statements regarding the growth and improvement of the service, which is said to be not a source of great financial gain. 1,200 w. St Ry Rev—March 15, 1897. No. 11,615. 30 cts.

OVERHEAD Railway.

Framework ofr Overhead Railways (Charpente pour Chemins de Fer Aériens). Design for overhead truss for cars suspended beneath the rails. 1,000 w. La Revue Technique—March 10, 1897. No. 11,759. 30 cts.

PARIS.

Claret-Vuilleumier Tramway of Paris. Illustrated description of an electric line with underground connections, of peculiar construction. 900 w. W Elec—March 13, 1897. No. 11,580. 15 cts.

PLEASURE Resorts.

Amusement Features at Willow Grove Park, Philadelphia. Description, with two-page engraving of the attractive features of a pleasure park near Philadelphia, constructed for the Union Traction Co. 3,200 w. Eng News—March 11, 1897. No. 11,544. 15 cts.

POWER Station.

The Dorchester Power station of the West End St Ry Co., Boston, Mass. H. W. Weller. Illustrated detailed description. 2,500 w. Elec Eng—March 24, 1897. No. 11,863. 15 cts.

Notes on Electric Railway Power Stations. Henry A. Lardner. Stations operating five, twenty-five and one hundred cars respectively are considered. 3,000 w. Wis Eng—Jan., 1897. No. 11,856. 45 cts.

The New Power Station of the Chicago City Railway. Illustrated detailed description of the new station at Forty-ninth street and Oakley avenue. 3,000 w. St Ry Jour—March, 1897. No. 11,777. 45 cts.

RAILS.

The Solution of an Important Street Railway Problem. The difficulty of using the two kinds of rails used in the cities and for suburban roads, without loss of speed or danger. Solved by a design of truck, and successfully tested. Ill. 800 w. St Ry Rev—March 15, 1897. No. 11,618. 30 cts.

RAPID Transit.

Rapid Transit in New York. G. Lindenthal. Discusses the conditions likely to affect the financial prospects of any new rapid transit railroad and suggests a plan that would give relief to suburban and city pasengers from the north. 1,200 w. RR Gaz—March 26, 1897. No. 11,883. 15 cts.

Some Considerations on "Rapid Transit." Editorial comment called forth by the paper of W. L. Derr, presenting some of the strict conditions which must govern any intelligent study of this subject. 1,500 w. RR Gaz—March 19, 1897. No. 11,695. 15 cts.

RECONSTRUCTION.

Reconstruction of Cable Track in Cincinnati. Bert S. Baldwin. Description of method of reconstruction which progresses while both electric and cable cars are operating. 1,500 w. St Ry Rev—March 15, 1897. No. 11,616. 30 cts.

REPAIRS.

Some Statistics on the Life of Brake Shoes, Gears, Pinions and Trolley Wheels. Particulars given are the result of inquiry instituted among a few companies. 1,300 w. St Ry Jour—March, 1897. No. 11,700. 45 cts.

SAN FRANCISCO.

Mill Valley andMount Tamalpais Scenic Railway. Brief description of road, with illustrations of the mountain-climbing locomotives. 400 w. Loc Engng—March, 1897. No. 11,462. 30 cts.

SHOPS.

Shops of the Cincinnati Street Railway Company. Illustrated detailed description. 1,800 w. St Ry Rev—March 15, 1897. No. 11,617. 30 cts.

SNOW Plow.

A Pneumatic Snow Plow. Illustrated description of a pneumatic snow plow used on the Atlanta Consolidated Street Railway. 500 w. St Ry Rev—March 15, 1897. No. 11,613. 30 cts.

SPEED.

Speed Ordinances. Replies to a letter of inquiry sent out for the purpose of learning what restrictions, if any, are put upon the speed of electric and cable cars in the principal cities of the United States. 1,700 w. St Ry Jour—March, 1897. No. 11,699. 45 cts.

SYRACUSE, N. Y.

Street Railway System of Syracuse, N. Y. Illustrated detailed description. 6,500 w. St Ry Jour—March, 1897. No. 11,697. 45 cts.

TORONTO.

Toronto Harbor and the Proposed Island Railway. Report of A. B. Ross, giving an estimate of cost of bridging the gap, with discussion of other objections. 2,200 w. Can Eng—March, 1897. No. 11,571. 15 cts.

TRACK.

Some Notes on Electric Street Railway Track. W. M. Camp. Points out present tendencies in street railway track construction as regards the types of materials used, the manner of putting them together in the track, and the methods of ballasting the track and the materials used therein. 4,200 w. Wis Eng—Jan., 1897. No. 11,857. 45 cts.

TRACTION.

Discussion of the Berlin Tramway. (Mittheilungen über die bei der Grossen Berliner Pferdeeisenbahn gemachten Eefahrurgen, &c.) An enegetic discussion before the German Railway Society as to the merits of various systems of propulsion; electric overhead and underground, also compressed air. 1 plate of rail joints. 6,000 w. Glaser's Annelen—March 1, 1897. No. 11,718. 30 cts.

Electrical Equipment of the Alley "L," Chicago. To be changed from steam to electricity, the road being divided into 18 sections, each about half a mile in length, each section to be supplied with current by a separate feeder. 1,000 w. W Elec—March 27, 1897. No. 11,902. 15 cts.

Some Opinions Regarding Electricity on the New York Elevated Railways. Opinions of William J. Fransioli and Sidney H. Short, on the feasibility of substituting electric for steam power and the advantages to be expected from the change. 1,500 w. Elec Wld—March 6, 1897. No. 11,501. 15 cts.

The Application of Mechanical Traction Upon Tramways. (Application des Moteur Mécaniques a la Traction des Tramways.) A general discussion of the subject, taking up seriatim steam, fireless locomotives and compressed air. Two articles of a series. 5,000 w. La Revue Technique—Feb. 25 & March 10, 1897. No. 11,755. 60 cts.

The "Simplex" Conduit System of Electrical Traction. Illustrated description of a model line of tramway laid at Prescott, Lancashire. 2,500 w. Elec Eng, Lond—March 12, 1897. No. 11,839. 30 cts.

TRAMWAYS.

The Construction and Operation of Electric Tramways. (Ueber den Bau und Betrieb elektrischer Bahnen.) A descriptive address by Herr Prasch upon the general details of electric tramway construction. Two articles. 8,000 w. Zeitsch d Oesterr Ing u Arch Ver—Feb. 26 & March 5, 1897. No. 11,730. 30 cts.

TRUCK.

The American Electric Truck. W. E. Partridge. A description of the truck as found in the best American practice. 1,000 w. Ry Wld—March, 1897. No. 11,601. 30 cts.

BOOKS OF THE MONTH

Hiscox, Gardner D., M. E. Gas, Gasoline, and Oil-Vapor Engines. A New Book Descriptive of Their Theory and Power, and Illustrating Their Design, Construction, and Operation for Stationary, Marine, and Vehicle Motive Power. Norman W. Henley & Company, New York. 1897. Cloth, $2.50.

We desire to enter a protest against term "explosive motor," of which the the author makes a free use. But, having made this demur, we are free to say that the treatise seems well conceived and the task well executed. The introduction gives a historical sketch of the progress in the theory and practical construction of this class of motors, which is followed by a chapter on the theory of the gas and gasoline engine. In the third chapter, which deals with the utilization of heat and efficiency, the principle is laid down that "the utilization of heat in a gas engine is mainly due to the manner in which the products entering into combustion are distributed in relation to the movement of the piston." The efficiencies of the earlier and later types of engines are then reviewed. Twenty-four chapters follow, and a final one deals with United States patents on gas, gasoline, and oil engines. In the discussions of the various topics which fill the book,—an octavo of 350 pages,—the practical side is mainly dealt with. The work is handsomely printed and copiously illustrated.

"The Electrician" Electrical Trades Directory and Handbook for 1897 (Fifteenth Year). "The Electrician" Printing and Publishing Company, London. 1897. Cloth. 7s. 6d.

This work has been revised and corrected up to January 31, 1897, and, in addition to the usual large amount of useful trade information ordinarily comprised in it, it contains for the first time: (1) a large sheet table, giving technical particulars of the railways and tramways of the United Kingdom; (2) regulations regarding the free supply of incandescent electric lamps; (3) the new regulations of the London county council for electric meter testing; (4) a number of useful tables relating to water power, British coal, dry saturated steam, hydraulic heads, feed-water heating, rope gearing, etc.; (5) an interesting historical sketch of the international telegraph bureau at Berne; (6) the Buda-Pesth (1896) revision of the international telegraph tariff; (7) a new section of the directorial division, dealing with Japan and the Far East, which contains the names, professions, and addresses of all persons in those parts of the world associated with electrical work; (8) a carefully-compiled sheet table, giving exhaustive particulars of the electricity-supply stations of the United Kingdom, (to February, 1897); (9) a revised digest of the law of electric lighting; (10) ditto of the law of electric power (for traction purposes); (11) the latest revised rules of British, American, Canadian, French, and German fire insurance corporations, relating to electrical risks. All the old and well-known features of the book are retained, but are rigidly brought up to the date of publication.

Bailey, G. H., D.Sc., Ph.D. The TUTORIAL CHEMISTRY. W. B. Clive, London; Hinds & Noble, New York, 1877. Cloth, $1.00.

What we have said elsewhere in terms of general approval of the University Tutorial Series sufficiently implies our estimate of the value of this treatise on chemistry. Although a small treatise upon a very large subject, it has sufficient space to present a systematic outline of chemistry, so far as it relates to the nonmetals. Chemical theory is only slightly discussed, as the book is for students in the earlier stages of progress. A union of experiment, observation, and inference is combined with such descriptions of experiments as will, under the guidance of a teacher, render it useful in the laboratory.

Le Van, William Barnet. The Practical Management of Engines and Boilers. Including Boiler Setting, Pumps, Injectors, Feed-Water Heaters, Steam-Engine Economy, Condensers, Indicators, Slide Valves Governors, Steam Gages, Incrustation and Corrosion, etc. A Practical Guide for Engineers and Firemen and Steam Users Generally. The Philadelphia Book Company, Philadelphia. 1897. Cloth. $2.

Mr. Le Van is well and widely known as a consulting steam engineer, being a mem-

ber of the American Society of Mechanical Engineers and of the Franklin Institute, which are doing more for the advancement of mechanical engineering than all the other technical societies in the United States. The title suggests quite a wide range of topics; the size of the volume indicates that an exhaustive treatment has not been attempted. The book, which embodies the author's experience of more than forty years, is eminently practical, covering a large number of points for which an engineer or fireman would like to have a ready-reference book. It is well indexed.

Hogg, Prof. Alex. M. A., Superintendent of Schools, Fort Worth. John P. Morton & Company, Louisville. 1897. Paper.

This consists of an address delivered, presumably at Fort Worth, in 1885. Many changes have taken place since the address was delivered, and to the 24 pages which it occupies are added 104 pages of statistical and general information of progress in railroading since the year named. A statement of notable gifts and bequests to educational institutions by eminent railroad men forms a portion of this collection of addenda. A section is also devoted to fast runs, and some interesting biographical sketches are supplied.

Johnson, John A. South America, Its Resources and Possibilities. Agricultural, Pastoral, and Dairy Resources Described. M. J. Cantwell, Madison, Wis. 1897. Paper. Copies supplied by the Gisholt Machine Company on application.

The author of this little book is president of the Fuller & Johnson Mfg. Company, and also of Gisholt Machine Company, of Madison, Wis., and he was a member of the delegation of the National Association of Manufacturers that visited South America last year in the interest of international trade. The work is in two parts, the first part comprising a series of letters written from South America, describing the resources of Brazil, Argentina, and Uruguay, and proposing plans for a more extended commerce with those countries. Part second contains suggestions of lessons that may be drawn from the experiences and conditions of the people.

West, Thomas D. Metallurgy of Cast Iron. A Complete Exposition of the Processes Involved in its Treatment, Chemically and Physically, from the Blast Furnace though the Foundry to the Testing Machine. Fully illustrated. First edition. The Cleveland Printing and Publishing Company, Cleveland Ohio. 1897. Cloth.

The author of this treatise is doubtless the highest authority in the United States upon the metallurgy of cast iron. He has, in our opinion, done more to advance the art of iron-founding than any other man of the period. He is not only a thoroughly practical moulder and foundryman, but his educational and literary qualifications, exemplified in his contributions to the literature of cast iron, have been recognized by prominent societies and associations of which he is a member. His high reputation is well sustained by the present publication, which covers the entire ground, as proposed in the title, in a masterly manner. Foundrymen who do not possess the information presented in this able treatise must fall behind the age in the theory and practice of their art, and, probably in their struggle with competitors.

BOOKS RECEIVED.

Interstate Commerce Commission. Eighth Annual Report on the Statistics of Railways in the United States for the Year Ending June 30, 1895. Prepared by the Statistician to the Commission. Government Printing Office, Washington, D. C. 1896. Cloth.

Mac Cord, Prof. C. W., Sc. D. (a) A Curious Mechanical Movement. (b) Olivier Models Remodeled. (c) The Helical Convolute, or Single-Curved Surface with a Helical Directrix. Pamphlets, reprinted from *The Stevens Indicator*. Paper.

Jackson, Prof. Dugald C. Mem. W. S. E. The Equipment of Manufacturing Establishments with Electric Motors and Electric Distribution. Pamphlet, Reprinted from Translations of the Western Society of Engineers. Paper.

Wallis-Tayler, A. J., C. E. Bearings and Lubrication; A Handbook for Every User of Machinery. Imported by D. Van Nostrand Co. New York. Cloth, $1.50.

Annotated Bibliography of Fine Art; Painting, Sculpture, Architecture, Arts of Illustration, and Illustration, by Russell Sturgis; Music by Henry Edward Krehbiel. Edited by George Iles. Published for the American Library Association Publishing Section, by the Library Bureau, Boston. (146 Franklin street); New York (280 Broadway); London (10 Bloomsbury street, W. C.).

Annual Report of the Minister of Mines for the year ending 31st December, 1896. Being an Account of Mining Operations for Gold, Coal, etc., in the Province of British Columbia. Richard Walfenden, Victoria, B. C. 1897. Paper.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

The Farrel Foundry and Machine Co., Waterbury, Conn., U. S. A.=(a) Leaflet describing and illustrating bicycle machinery. (b) Ditto: Hardware machinery. (d) Ditto: Silverware machinery. (e) Ditto: Tube-mill machinery. (f) Ditto: Rolling-mill machinery. (g) Ditto: Annealing and case-hardening furnaces. (h) Ditto: Hydraulic draw-benches, presses, pumps, and accumulators.

The Ball Bearing Co., Boston, Mass., U. S. A.=Catalogue (1897) of "Hub" ball and roller bearings for machine construction and line shafting.

C. M. Turnquist, Chicago, Ill., U. S. A.= Catalogue and price-list of electrical supplies.

Willis Shaw, Chicago, Ill., U. S. A.=Booklet of second-hand machinery and contractors' equipment ready to ship.

The John H. McGowan Co., Cincinnati, Ohio, U. S. A.=General catalogue of pumping machinery.

Aultman & Taylor Machinery Co., Mansfield, Ohio, U. S. A.=Catalogue, nicely printed, profusely illustrated, and bound in stiff covers (buckram). This catalogue is, in reality, an essay on steam production, in which the evolution of steam generators up to the later end-of-the-century types, including the Cahall water-tube boiler, is logically traced. This is followed by a full illustrated description of the Cahall boiler, one of the latest claimants for public favor, with details of construction, explanation of its operation, and much other interesting matter.

Henry Maurer & Son, New York.=Illustrated Catalogue for 1897. Illustrates and describes an important line of fire-proof building materials,—for example, flat and segmental hollow clay arches, partition and furring blocks, column and girder protection, roof and ceiling-blocks, fire-clay flue linings, porous terra cotta, etc.

Mason Electric Equipment Co., Chicago, Ill., U. S. A.=Circular illustrating and briefly describing a line of electric railway supplies.

Kennedy Valve Manufacturing Co., New York.=Price list (illustrated) of a line of valves manufactured by this house.

Hilles & Jones Company, Wilmington, Delaware, U. S. A.=Elegantly illustrated and printed large quarto cataogue, including recent designs for working iron and steel plates, bars and structural shapes. The cuts are tinted and printed on finest quality of coated paper with descriptive text.

New York Telephone Co., New York.=Illustrated pamphlet containing a description of the private branch exchange system of supplying New York city telephone service.

Ingersoll-Sergeant Drill Co., New York=Illustrated descriptive catalogue of high-duty air compressors, in a variety adapted to cover all the uses to which compressed air can be applied, with dimension tables and other data.

Westinghouse, Church, Kerr & Company, New York, Boston, Pittsburg, and Chicago.= Pamphlet entitled "Refrigeration." Illustrates and describes the refrigerating apparatus manufactured by this company. Elegantly printed, and also containing illustrations of successful installations.

The Clonbrock Steam Boiler Company, Brooklyn, N. Y., U.S.A.=Catalogue for 1896 illustrating and describing the (patented) Morrin "Climax water-tube safety boiler."

The Garvin Machine Co., New York.=Illustrated catalogue and price-list of an extensive line of machine tools, and of special labor-saving machines for bicycle construction.

The Detroit Lubricator Co., Detroit, Mich., U.S.A.=(*a*) Catalogue for 1897. Illustrating and describing full line of hot-water and steam radiator valves, comer valves, globe valves, etc., and giving a special description of the quick opening steam and hot-water valves made by this company, with a statement of their advantages. (*b*) Leaflet, illustrating and describing the improved standard stationary engine lubricator.

The Lehigh University, South Bethlehem, Pa., U.S.A.=Course in Electrical Engineering, under direction of Alexander Macfarlane, M.A.D.Sc., LL.D.

James L. Robertson & Sons, successors to Hine & Robertson Co., New York.=Catalogue of indicators, reducing wheels, planimeters, damper regulators and other appliances for the convenient, safe and economical operation of steam-boilers and steam engines, "Eureka" packing, tools and supplies.

Automatic Friction Clutch Company, Erie, Pa., U.S.A.=Catalogue and price list describing and illustrating the automatic and friction clutch and cut-off coupling manufactured by this company.

The Hayden & Derby Manufacturing Co., New York.=Catalogue of injectors, comprising the "Metropolitan Automatic," "Metropolitan Double-Tube" and "H-D injectors."

Montgomery & Co., New York.=Leaflet, illustrating and describing the Robbins' lathe tool.

Clayton Air Compressor Works, New York, U.S.A.=Catalogue of compressed-air tools and appliances, claimed to cover the entire line, and to be the first catalogue ever published that did cover the whole field.

Boston Belting Co., Boston, New York, Buffalo, U. S. A.=Pamphlet "Suggestions for Your Benefit and Ours." Written in a conversational style, beautifully printed and illustrated on tinted paper, and containing useful hints for those contemplating alterations, improvements, increase of manufacturing facilities, or replenishing depleted stock.

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THE IMPORTANCE OF THE UNIVERSAL EXPOSITION OF 1900.

By J. C. Charpentier.

THE exposition of 1900 is now on the carpet. It is the question of the hour, and even in the remotest quarters of the globe it is the subject of many conversations and the occasion of many projects. In France the preparations for it are going forward with activity and are followed with interest; the temporary scaffoldings of the Pont Alexander III already stretch across the Seine, and a large part of the Palais de l'Industrie, one of whose wings sheltered but a few days ago the victims of the frightful fire in the Rue Jean Goujon, has been torn down. In foreign countries, especially in Germany, England, and in fact the whole of Europe, committees are being formed, plans are being sketched, and projects are taking shape; and even in the United States, where until lately more pressing problems, such as were involved in the national election, had absorbed the attention of the public, the current in favor of the exposition is swelling rapidly, and President McKinley invites his fellow-citizens to the great assizes with which a sister republic is to celebrate the close of the century.

And in Europe as well as on this side of the water the thought of every one reverts to the brilliant success of the exposition of 1889, which seems to have been the most memorable triumph imaginable, tempting one to renew the objection of a certain member of a former French cabinet: "What is the use of a new exposition, and how is it possible to break the record of 1889?"

Indeed, it was not simply a considerable competition of more than 60,000 exhibitors, an influx of more than 1,500,000 visitors from foreign countries and of 5,000,000 from the departments of France, but also an unprecedented movement of money, an enormous increase in commercial exchanges, in railway receipts (which made a leap that

year of more than 120,000,000 francs), in the work of the postal and telegraphic services, and in the movement of the minutest machinery of economic and industrial life.

And yet the organizers of the exposition of 1900 expect to achieve results still greater. And, however audacious their attempt may be considered, appearances thus far seem to justify them. Since the first exposition,—that of 1855,—the success of Paris expositions has been on an ascending scale. There were 10,865 exhibitors in 1855, 26,000 in 1867, 36,000 in 1878, and 61,000 in 1889. The admissions were only 5,000,000 in 1867; in 1889 they reached 23,000,000. It must not be forgotten, moreover, that in 1889 political reasons prevented the monarchical powers from participating officially, and that the national committees which in certain countries substituted private initiative for official participation seldom succeeded in presenting more than an embryonic exhibit. Now, in 1900 the participation will be universal. Furthermore, the exposition of 1889 had only 9 groups; that of 1900 will have 18 groups and 120 sections. The area allotted to exhibitors in 1889 was only 203 acres; in 1900 it will exceed 271 acres. The expenditure in 1889 was only 43,000,000 francs; 100,000,000 francs have been voted by the French parliament for the approaching international competition, and, finally, an attendance of 60,000,000 is expected. Again, the immense and peaceful struggle to which France has invited all the nations, coming at a time when commercial competition between the peoples of the earth has attained such activity, marks a cardinal date in economic life, and the spectacle offered to the world will be worthy of its admiration.

I.—THE SCENE.

To receive her guests Paris wishes to don holiday attire, and entertains grand schemes for her adornment. Chief among them are: (1) the Pont Alexandre III; (2) the two fine-art palaces; (3) the disposition of the banks of the Seine.

1. *The Pont Alexandre III.* On October 7, 1896, when his Majesty the Czar Nicolas II laid with a golden trowel the first stone of the monumental bridge which will bear his father's name, he not only gave to France a proof of his sympathy and confidence, but inaugurated for the great nations an era of peace and industry. It is not lightly and for months that these gigantic works are undertaken; it is for years; and this setting at work of thousands of laborers, this activity of entire France centred upon a single object, constitute one of the most eloquent manifestations of industry and peace. The construction of the Pont Alexandre alone is a task of long duration. Of the existing Paris bridges none are more than thirty meters in breadth, but this will measure nearly sixty; it will have but a single arch, of

immense proportions; the year 1897 will be devoted entirely to its foundations, the year 1898 to the metallic work, and the year 1899 to its decoration. Especial care will be given to this last; architectural motives and decorative figures, bold in conception and harmoniously disposed at the four corners, will make of it a veritable work of art.

2. *The two palaces.* These are to be built in the Champs-Elysées, and one can form no idea of the discussion which they have occasioned. To make room for them, in fact, it was necessary to tear down the Palais de l'Industrie, where all expositions and competitions and the art salons were held, and to this destruction much resolute opposition was offered. And yet the superior interests of the exposition demanded it; to use the language of one of the most ardent promoters of the exposition, France must not offer the old renovated and repaired; if she invites the world to Paris, the plan must be new, worthy of herself and of her guests. The cause of the palaces triumphed, and a grand competition was instituted for their design, resulting in the receipt of more than one hundred and ten plans signed by the most eminent artists. Those of MM. Girault and Esquié, both of which took the Grand Prix de Rome, were pronounced the best, and their publication warrants the assertion that the two palaces will constitute a *résumé* of French architectural art at the end of the nineteenth century. Twenty million francs are appropriated for their construction, and it will be insisted that the work be durable and definitive, it being the intention that the palaces shall survive the exposition that they may be used permanently for the salons, competitions, concerts, etc.

These two palaces, situated in the Champs-Elysées, will be, in short, the starting-point and the frame of the immense avenue which is to connect the Champs-Elysées with the Invalides and restore one of the finest views in Paris. At the outset the Champs-Elysées will present their fairy-like spectacle; then, crossing the river, the monumental bridge; farther on, the esplanade of the Invalides transformed into gardens laid out in French fashion, with balustrades, groups, basins, and plots of greensward, bringing into the heart of Paris a reminder of Versailles; finally, as a background, the sober lines of the Hôtel des Invalides, and, crowning all, the glittering gilded dome of Mansart.

3. *Disposition of the Banks of the Seine.* The idea of giving a special disposition to the banks of the Seine is neither less original or less happy. The stream of Mme. de Sévigné will be transformed by the wand of the architects into a vast Venetian canal lined with palaces and having broad banks, spacious, convenient, and restful, upon which the public may promenade. The picturesque façades of

the pavilions of exotic design will rise one above another, separated by terraces in the Italian fashion. In the daytime the activity of navigation, the multicolored flags, and the gaily-decked boats standing out in relief against the foliage of the trees will form an animated picture, full of color and sparkling gayety, and at night the fairy-like illuminations, for which all the resources of modern lighting will be drawn upon, and the glittering waters will furnish a marvellous setting for the Venetian entertainments and festivities.

II.—THE SECTIONS.

But the construction of a monumental bridge, the building of palaces, and the embellishing of the Seine furnish only the scene, the setting, in which the action will take place and the characters will move. I refer to the sections and their occupants, French and foreign exhibitors,—that is, the really instructive part of the exposition. The sections will be eighteen in number, distributed among as many palaces. Most important among them will be the palaces of Education, of Social Economy, of Decoration and Furnishing, of Pottery and Glassware, of Horticulture, of Foods, of Stuffs and Garments, of Machinery and Metallurgy, of Means of Transportation, of Electricity, of Navigation and Commerce, of Colonization, and of Literature and the Arts and Sciences. A special section will be established for Physical Contests, Sports, Bicycling, etc. But the two which promise to attract the most attention are, beyond question, those of the Means of Transportation and of Electricity. The former is entrusted to M. Jacques Hermant, who was the French architect at the Chicago World's Fair, and we may be sure that the new agencies of locomotion, notably the automobile carriages now so much used in Paris and London, as well as bicycles and the various sorts of street railway, will appeal to inventors and to the curiosity of the public. But the Palace of Electricity, under the management of M. Henard, will be one of the drawing cards of the exposition. By day it will supply motive power to a series of machines, and at night, by a special connection, it will supply light for the illuminations of the Salle des Fêtes. It will be built entirely of glass, and will shine in the night like a gigantic beacon.

One of the most characteristic features of these sections and of the exposition itself will be the method to be adopted in their general organization. It has often been urged against expositions that their technical exhibits are nothing but vast commercial museums in which, to be sure, one may see machines, but machines that are not in operation, or, if in operation, are doing no productive work. Now, the finest commercial museum in the world attracts but few visitors ; the vestibule is the most frequented part of it, and even that is sought only

on rainy days. It will not be thus with the exposition of 1900. Its essential and wholly new principle consists in the uniform placing, beside the manufactured product, of the machine used in its manufacture and the processes of its production; and this fertile principle, which does the greatest honor to the promoters of the French exposition and notably to its director-general, M. Picard, will transform the general physiognomy of the exposition, will give life to the features hitherto looked upon as uninteresting, and will give the public valuable object-lessons. Better still, a methodical plan is contemplated, whereby the visitors will be able to follow the raw material through its various transformations without deviating from the course of their promenade. It is in the operation of this immense work-shop that will be employed the electrical resources already mentioned.

III.—THE FOREIGN EXPOSITIONS.

All these extensive preparations, all these efforts on the part of France to make the exposition an unprecedented thing, were sure to make an impression on foreign nations and impel them to unanimous coöperation. Accordingly that is what has happened. Of all the foreign governments to which invitations have been addressed by France, but one, Egypt, has declined to participate officially. Two, it is true, the United States and Switzerland, have as yet made no reply, but all the other governments, sixty in number, have accepted officially, and almost all have already appointed their commissioners and presented their applications for space. Comparing these applications with those made in 1889, one perceives at a glance the considerable importance that the approaching exposition will assume. The following are the figures for the principal countries:

	1889. Square feet.	1900. Square feet.
Argentine Republic	17,600	27,500
Austria-Hungary	36,388	640,200
Belgium	150,242	259,864
Cape of Good Hope	0	44,000
Germany	25,264	396,000
Italy	57,171	121,000
Japan	28,589	107,000
Mexico	23,000	44,000
Russia	49,764	528,000
Spain	41,185	50,500

Some of these figures are eloquent. Germany, whose participation at Chicago occasioned so much comment, is preparing to do better yet. The emperor desired that the invitation be accepted, and he has been followed by the entire commercial interest of the nation, so that throughout the empire an extraordinary movement is in progress. The commissioners, MM. Richter and Lewald, were

among the first appointed ; at Berlin offices have been established, in which the work of organization is going forward, and active preparations are being made for this new economic struggle. Germany will be represented in all branches in which she can exhibit advantageously, notably in machinery, chemistry, optics, and electricity. Three other groups in which indisputably she will occupy a first place are those of protection of laborers, hygiene, and public instruction. Lastly, she will participate in the theatrical exposition by a model of the great Wagner theatre at Bayreuth.

England, which in 1889 had 230,000 square feet, has not yet made known the exact figure of her needs, but she has reserved her rights in expressing a desire that as much space may be allotted to her as shall be enjoyed by any other nation. No less notable are the demands of Austria and Russia, which in 1889 refused to participate officially, but which are determined on this occasion to give their full measure. Japan, too, with her application for 107,000 square feet, shows her intention of manifesting to the united world at Paris her quality as an industrial power of the first rank.

As we have said, the United States have not yet forwarded to the French government an official acceptance, or made known the extent of their participation. It is useless to try to conceal the fact that this silence has not failed to provoke comment. It has been remarked that, when the Columbian administration invited foreign nations to the Chicago exposition, France was the first of all to respond to the appeal, placing herself at the head of the list of coöperating countries. But the delay of the United States finds its very natural cause in the American presidential election and consequent change of administration, and it is perfectly well recognized in France that not the slightest significance is to be attached to it. Furthermore, President McKinley's warm appeal excludes all possibility of misunderstanding. Nevertheless the time has arrived when the United States should definitively join in this movement of the foreign nations. In these peaceful assizes in which the foremost industrial powers, England and Germany, are so actively preparing to measure themselves against France, it is important that the great commercial republic of North America should claim the place that belongs to her. In machinery and metallurgy her participation is indispensable. Her machinery; her metallurgical plants, so surprising in their boldness ; her newspaper presses, which recently enabled certain great New York journals to accomplish results so marvellous,—these ought to figure at Paris as monuments of the industrial activity of this great nation. In the department of Means of Transportation the United States, which possess the greatest network of railways in the world, equal in extent to that

of all Europe, and superior in comfort and luxury to anything imaginable, should occupy a first place. As to their supremacy in electricity, is it not enough to mention the name of Edison? And just as Japan has manifested her intention of signifying to the assembled world her quality as a great industrial power, should not the United States also establish the important position of their maritime power by showing, in the department of Military Marine, the most recent models of their warships? But considerations so important cannot have escaped public attention, and there is no doubt that the United States are determined to participate in this great international tourney in a manner worthy of them.

The quasi-unanimity with which foreign nations have officially accepted, and the exceptional importance of the foreign exhibits, will constitute one of the characteristics of the exposition of 1900 and its superiority to its predecessor of 1889, in which, it will be remembered, official coöperation was somewhat rare. One of the consequences easily to be foreseen is that the sovereigns who have shown so much enthusiasm in entering into the plans of the French republic will be led by the same enthusiasm to personally respond to her invitations to visit the exposition, and Paris expects for 1900 an influx of royal visitors such as has not been seen since 1867, whose presence will be the most striking homage to the government of the republic.

But the chief importance of this competition will be found in its higher lessons. During the second half of this century scientific progress, especially in electricity, has been so rapid, inventions have been so numerous, and discoveries have been so brilliant, that we feel, as it were, the need of taking breath and of traversing with the eye the road which we have covered. In economic life it is necessary, not to halt, for economic progress allows no time for that, but to note from time to time the advance that we have made and register it by mile-posts. It is a wise and useful thing to measure the distance traversed, to compare it with that traversed by our rivals, and to derive, from this look backward, instruction and profit.

That is the service which universal expositions render. In this respect the exposition of 1900 promises to surpass all others. At this end of a century of progress all the nations invited by the French republic are coming, to take part in a grand international tournament. All of them understand how important it is for them to participate. Let us await them with confidence and serenity. It is a comforting, a reassuring spectacle,—these peaceful preparations of the civilized world. There is no surer sign of peace, for such displays and expenditures of activity and effort require luminous skies and sunny horizons.

THE PHYSICAL ASPECT IN RAILROAD ACCOUNTING.

By Thomas F. Woodlock.

RAILROAD accounting, in the sense of information published for the use of security-holders, constitutes a part of corporation management, which is, or should be, more important than many people esteem it. I believe that it might be made a most potent influence for good management and a thoroughly efficient protection for investors by the adoption of a rather different theory of construction of railroad reports. The suggestions which follow are the fruit of practical study of railroad reports, and are offered with some confidence, because a layman or investor may perhaps claim to know better just what he requires in the way of information about his property than even the trained and experienced accountant who prepares that series of abstracts from the company's books which commonly goes to make an annual report.

The study of the purely financial aspect of railroad reports, which practically begins with "net earnings," is good, as far as it goes. It is frequently very complicated, and occasionally makes considerable demands upon the skill and patience of the analyst. It is all built, however, upon the general assumption that the "net earnings" of the company are correct, and it busies itself chiefly with the disposition of "net earnings" and the manipulation of capital.

"Net earnings" are the *result* of "gross earnings" and "operating expenses," however, and only in these two items do we come really in contact with the operations of the machine itself, so to speak. Net earnings are, as it were, the power delivered on the first floor by belting from the engine in the basement. If we look only at the belt, we know nothing at all about the engine, and some day, when the belt stops, we are surprised, because it has run along without a break to the last minute. We ought also to study the engine, at least a little.

The point that I am endeavoring to make is that the majority of railroad reports—in fact, almost all of them—are lacking in that they do not bring readers close enough to the actual operations of the machine. They deal too much with results, and too little with causes. If they were so constructed as to show at once the real physical circumstances of the road's operations, a much better idea of the company's position would be given. In a word, the physical aspect has not been sufficiently considered in railroad accounting as a whole, and,

where it has been sufficiently considered to ensure publication of the main facts in the report, these facts, as a rule, have been so buried under detail as to convey but a confused idea to the lay reader.

If a man holds as an investment a stock or bond of a railroad, the chief thing that he wants to know is whether or not his interest or dividends will continue, and (if he holds a bond) whether or not the security for the payment of his principal is sufficient. As a matter of fact, the essential question at all times is whether or not *net earnings* will be always sufficient to meet interest or dividends, because security for principal eventually depends entirely upon net income. Therefore, what a security-holder really wants to know is whether the earning power of his property is increasing or diminishing, and whether it is what it ought to be. This involves comparison of a company's record in a given year with its record in previous years. It also necessarily involves a clear exposition of all matters directly affecting the earning power of the company.

The net earning power of a railroad depends upon two things: first, the character and volume of business offered to the company; second, its capacity for handling it economically. The first comprises all matters affecting rates, density of business, length of freight haul, or average distance travelled by each passenger, and other kindred matters. The second comprises all matters relating to operating expenses, such as the average train load of freight or passengers, the efficiency of motive power and rolling-stock, the condition of track and structures, etc. When a clear idea is obtained of these things, it is evident that a clear idea is obtained of the earning power of the company. What we want to know, therefore, is everything that bears upon these things in any appreciable degree.

I.—*Character and Volume of Business; Gross Earnings.*

(1) We want to know the sources of the company's gross earnings; what proportion is passenger earnings, what freight, and what miscellaneous. Practically all companies show this.

(2) It is very desirable that, in showing freight earnings, the amount in dollars and cents contributed by each kind of freight, and the tonnage of each kind of freight, should be stated separately. The average rate per ton per mile of each kind of freight should also be stated. Most railroads report the percentage of total tonnage borne by each kind of freight, but practically none give the statistics called for above. Presumably the statistics are available on the books of all companies. Their chief value would be in showing basic changes in the character of the company's business, thus explaining important changes in earnings and expenses.

(3) The "average haul" of each kind of freight should be sepa-

rately shown. This would be extremely valuable as affording annual comparisons which would throw much light on the conditions under which the company was operating. It could, of course, be calculated from the "revenue per ton" of each kind of freight by dividing it by the "rate per ton per mile," but it would be well to state it separately.

(4) The company should state in each of its reports the "passenger density" and "freight density" of the road for a series of years. "Density" is arrived at by dividing the "passengers carried one mile" and "tons carried one mile" by the mileage operated, and gives the best idea of the volume of business done by the road. Very few companies report it, although almost all report the factors necessary for its estimation. It would also be well to report separately the density of the principal kinds of freight, so as to show where a road is gaining or losing in business. At times this would be a most valuable showing, with a very direct bearing on net earnings and the cost of operation. Certain kinds of business are more expensive to handle then other kinds; hence the variations in proportion between the various kinds of freight, and the density of each, are full of significance as bearing upon net earnings.

(5) It is desirable that reports should show the *direction* of a com pany's business, especially freight. Most roads in this country run east and west or north and south, and some show the volume of business moving each way. This has a direct bearing on loaded- and empty-car-mileage. It is necessary that the character of the freight tonnage going each way should be shown, because a mere record of tonnage is not sufficient. If the business one way is all cattle, and the business the other way all grain or coal, it is clear that, while the tonnage may be apparently equal, the empty-car-mileage will be apparently unaccountably large, because cattle cannot be shipped in box or coal cars, nor can coal or grain be shipped in stock cars. Hence the necessity for distinguishing.

(6) It is desirable to state local freight and through freight separately. Local freight may be taken as that which originates on, or is destined to points on, the company's own line.

(7) When the line does a very large passenger business, passenger statistics should be shown in the same detail as that prescribed for freight,—the object being to show plainly the company's main sources of business, the character and volume of that business, the revenue derived therefrom, and the circumstances under which it is obtained.

(8) It is very desirable that, where the business of a road is unevenly distributed over the year, being very heavy in certain seasons and very light at other seasons, a clear statement of tonnage for each

month should be made. This might throw a good deal of light on the sufficiency or insufficiency of equipment when judged by the foreign car-mileage. A road which had a big rush of business for three or four months in the year might well afford to pay considerable car-mileage rather than burden itself with equipment which would be useless for the remainder of the year.

When statistics such as these are available, anyone can form a fairly clear idea of the kind of business a company is doing, and how it is likely to be affected by circumstances as they crop up. That is really the main thing an investor wants to know about his property, as far as gross earnings are concerned. It is an unfortunate fact that, while most railroad reports are replete with statistics bearing upon other matters, very few of them give anything more than bare outlines regarding the nature of the business from which they derive their gross earnings. Surely it should be possible to amend them in this respect without much trouble, and the facts called for above could probably be given without detriment.

II.—*The Handling of Business; Operating Expenses and Net Earnings.*

When an investor has a clear idea of the kind of business his company is doing and the circumstances under which it is being done, he wants to know whether or not the business is being done economically, and whether or not the condition of his property is being sufficiently maintained. He wishes to know whether the net earnings reported have really been earned after a proper charging up of expenses for all purposes, and he wishes to know also if the property has been kept up to a full standard of efficiency. Evidence on these points is largely circumstantial, but is, on the whole, very important and often conclusive.

He knows that net earnings are what remain after operating expenses have been satisfied, and he knows that operating expenses should provide for the actual cost of transporting freight and passengers and for the full and proper maintenance of the company's property. What he wants to determine is whether operating expenses have been too heavily charged for transportation and too lightly charged for maintenance. It is practically impossible to economize unsafely in the conducting of transportation, if the business is done, and it is also almost impossible to unwisely construe maintenance too liberally, as far as expenses are concerned. The first thing he looks to is whether or not sufficient expenditure has been made on maintenance.

(1) The amount of money spent on each mile of roadway for maintenance of all kinds should be clearly shown in comparison with previous years,—five at least, and ten if possible. It will be seen readily if there is a tendency to increase or decrease expenditures in this respect. The actual amount is of no great importance in itself, and

must necessarily vary very much on various roads, but a comparison with previous years is necessary as far as a given road is concerned.

(2) The amount of money spent for maintenance of equipment should be separately shown for locomotives, passengers, freight, and company cars, and the average expenditure on each locomotive, passenger, freight, and company car should be shown in comparison with similar figures in previous years. In this way the tendency of expenses will show itself very plainly. Few railroads report expenses in this way, and many of them do not afford materials for arriving at the required facts. It is commonly estimated that an expenditure for repairs and renewals of $1,000 per locomotive, $500 per passenger car, and $40 to $50 per freight car are about the level of average safety on standard roads. An investor must, however, be guided by the previous record of the road, especially taken in connection with capital expenditure for equipment. If this latter is heavy and expenses for maintenance are decreasing, the inference is that operating expenses are not being sufficiently charged. The converse, of course, is also true.

(3) Inasmuch as trains must be run, while maintenance may be postponed for a time, it is generally safe to reckon that little or no money is actually lost in direct expenses for conducting transportation. It is impossible to save largely under this head, and at the same time run the same number of trains. It takes about as many pounds of coal, pints of oil, and pounds of waste, and as many men and as much time, to run one thousand engine miles on one road as on another; at all events the variation will not be extremely large. Therefore it is extremely important to know exactly how much is being earned by each engine-mile, or, rather, by each train-mile, for it is in the waste or saving in train-mileage that money is gained or lost. Our investor therefore will call for a statement of the number of train-miles (freight and passenger), the number of tons of freight hauled in each freight train on an average, and the amount earned by each freight train per mile run; and similar information for each passenger train. Most companies report this information, but many do not. From it one can judge very closely of the relative efficiency of one's property. One road will show a constantly decreasing number of tons per train, while another will show an increase just as steady. The investor in the former property will have no difficulty in making up his mind that there is something wrong, and it will probably first show itself in increased expenses for "conducting transportation."

If he looks deeper into the matter, he will probably find the trouble in the maintenance-of-way department (arising from failure to renew rails, ties, bridges), or in the maintenance-of-equipment department,

in the shape of inefficient motive power, shortage of cars through failure to make renewals, etc. This shows the importance of a clear statement of average expenses for maintaining each mile of roadway, each locomotive, and each car, over a series of years. Every train-mile saved means, on an average, at least thirty to forty cents in money.

(4) Another important thing is the mileage of foreign cars on the company's road, together with the mileage of the company's cars on foreign roads. Large mileage of foreign cars, not offset by large mileage of cars on foreign roads, frequently shows shortage of equipment, and is one of those things that throw light on the condition of a property.

(5) The amount of tons carried, on an average, in each loaded car and the proportion of loaded cars to empty cars are also of importance in determining the efficiency of a property. Many roads state them, but many do not. It is needless to explain the bearing of these items.

By a comparison of items such as those above suggested with similar items in former years, an investor or critic can form a very fair opinion as to whether or not operating expenses are sufficiently charged (they are practically never overcharged, as regards items of *maintenance*; certainly never from a conservative point of view), and whether or not the property is being efficiently operated. From this he can determine whether or not the company is actually earning what it claims to be earning. That is really the most important thing to determine with regard to a railroad, and unfortunately it is just the thing that is not shown by most companies.

Once an investor has satisfied himself of the integrity of net earnings, he knows exactly the position of his security, as "fixed charges" are not susceptible of change or manipulation at will. We have already assumed on his part a knowledge of the ordinary features of a balance-sheet covering the company's finances.

The physical aspect of railroad accounting is therefore nowadays far more important than the more technical financial aspect, because it brings the investor closer to the actual causes, whose effects are shown in final results. No report is thus complete, unless it shows:

(1) The character and composition (actual in tons and percentage of the whole) of the company's business, and the circumstances affecting each part thereof, including length of haul, density, revenue, and direction of business.

(2) The circumstances surrounding the handling of this business, designed to show the efficiency of equipment and road-bed and sufficiency of expenditures for maintenance, as affecting the integrity of net earnings from operations.

The fact that railroad accountants have as yet failed to appreciate the full importance of the physical aspect of railroading is shown by the fact that the chief standard, or unit, or "coefficient," of efficiency—*viz.*, the train-mile—has not yet been fixed in scientific uniformity by all the railroads. It is very doubtful if any two leading railroads in this country report train-miles in precisely the same way. By train-miles are meant revenue train-miles, or train-miles directly earning revenue as opposed to "switching" mileage or "work" mileage.

While the train-mile may not be an absolute standard of comparison,—it is certain that no absolute standard can ever be discovered,—it is unquestionably the best. The running of trains is the characteristic act of a railroad, and the mile is the natural unit of distance. The running of a train one mile is, therefore, the natural measure of earnings and expenses. The problem simply is to arrive at a proper definition of a train, and a clear demarcation of the dividing line between an engine and car doing "switching mileage" and the same engine and the same car doing "revenue-train-mileage." Every railroad accountant seems to go as he pleases in this respect, with sublime indifference to the methods adopted on other lines. Hence the absence of values in comparisons now instituted on a train-mileage basis between two roads. By the adoption of uniform train-mileage, results could be obtained that would be worth something. It would be a good thing for the interstate commerce commission to work a little on this point, as they worked on classification of operating expenses, and as they are working on classification of freight.

I may perhaps be allowed to make the suggestion that in corporation matters it is quite useless to look to congress for wise legislation. The people who can in a moment institute the necessary reforms are those powerful bankers who control absolutely the railroad finances of this country. To be plain, Mr. J. Pierpont Morgan, for example, can do more in five minutes in this direction than congress is likely to do in five or fifty years.

If we ever get real corporation reform, it will come from these men. Some of them have accomplished something in this direction in the last few years. A Missouri Pacific annual report now is eloquent when placed alongside a report of the same company for five years ago. A closed construction account on Louisville & Nashville is a valuable lesson, though we learned it from depression. The silent revolution in Pacific Mail's affairs since 1893 is also significant. These are straws, but they show which way the current is flowing. Perhaps the current may be more than an eddy. It all depends on the great banking interests in our corporations.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

I.—REASONS DETERMINING THE CHOICE OF ELECTRIC MOTIVE POWER.

THE uses of electrical energy in the mechanic arts are now so varied that it would require no small space merely to catalogue them. Many of these applications are utterly devoid of technical interest, consisting merely of coupling a motor to one machine instead of another. Overlooking, however, the whole field, the application of electricity to mechanical processes seems to divide itself, as Cæsar divided Gaul, into three parts. First, in point of time and aggregate commercial importance, stands the introduction of electric motive power into machine-operating establishments. The inducement to this step is simply the lessened cost of power that comes from a method of distribution the most efficient yet devised, with the added advantage that comes from generating power in large units rather than small ones.

Second in order of present importance come electric labor-saving devices,—those applications of electric power which are primarily directed not so much toward the cheapening of the power used as toward its employment in the most direct way and with the minimum amount of labor. There are many operations in which the change from crude to refined motive power means an enormous reduction in the use of the human machine, and such change is in this country of particular economic importance.

Finally, we must consider the profoundly interesting class of cases in which the employment of electrical energy has not merely cheapened and facilitated some mechanical operation, but has radically changed the process itself, giving us not only new conveniences, but new methods. Here electricity comes to the rescue by revising or replacing old ways of doing things, and thus saving power, or labor, or both.

The present paper will deal with the problem of electric motive power alone, and more particularly with the why and how of its use in machine-driving.

If a large group of miscellaneous machines requires to be driven, electric power is economical for two quite distinct reasons. In the first place, if the plant is a small one, electric power can often be obtained for less than the cost of steam or other power generated on the premises. Second, electric motors can be so applied as to lessen the waste of power in its distribution to the various machines. As regards

the first count, the conditions of economy are easily found. The aggregate cost of providing the power for a machine shop, for example, can be taken directly from the current expenditures. This cost, however, must be honestly reckoned, including all the incidental items chargeable to motive power, with due regard for depreciation.

If, including interest on the net cost of changing the motive power and depreciation on the motor, the use of electric power is cheaper than the existing power, then the use of an electric motor is at once indicated, without entering upon other considerations. As a matter of fact, the cost of power obtained by small steam engines, or even by small gas and petroleum engines, is rather high,—far higher than is usually supposed. Particularly is this true when, as often happens, power is used somewhat intermittently. Where the maximum power employed in driving miscellaneous machinery is, say, not more than twenty-five h. p., it is pretty safe to conclude that the power used costs, on the average, about ten cents per horse-power hour. Indeed, until one reaches a full output of fifty h. p. or more, the cost for intermittent work, such as is found in machine-shop practice, is more likely to exceed five cents per h.-p. hour than to fall short of it. Even the gas and oil engines, which work very economically on a uniform full load, are costly for intermittent work, since they have high friction and use gas or vapor very inefficiently on light loads.

The exact cost varies so much with the conditions that figures are somewhat misleading, but it is safe to say that, when electric power can be obtained at five cents per h. p. hour or less, its use is tempting, and in most cases advantageous. A few simple computations based on the total power expense will put the matter in its proper light.

But this is far from being the last word on the subject. The object in view, when one is investigating electric power, is, first, last, and always, economy. Now, there are two distinct ways of cutting down the total of the yearly power bill. First, one may buy his power at a cheaper rate than heretofore; second, he may manage to lessen his consumption of power. With good fortune he may be able to effect both economies. Electric motive power may prove economical for either reason or both, but its power-saving ability has been, and will be, its strongest recommendation to the more intelligent portion of the public. The logic of the matter is as follows.

Of the mechanical power required in a machine shop only a very modest proportion is actually utilized in the driven machines. The major part is frittered away in worse than useless friction by main shafts and jack shafts and counter shafts, by pulleys fixed and idle, by belts straight, half turn, and quarter turn, and by hangers, generally out of line.

The amount of this wasted power of course varies very largely according to circumstances, ranging from only a few per cent. to more than ninety per cent., as the transmission mechanism between engine and tools is well or badly ordered. Careful tests made on steam-driven workshops in France three or four years ago give perhaps the best idea of the losses in question. Twenty miscellaneous workshops mostly equipped with machinery for metal and wood working showed an average loss of no less than 40.7 per cent. between indicated h. p. and the machines—equivalent to the loss of not less than one-third of the net mechanical horse power. These shops employed less than 50 h. p. each, but the figures for larger plants are not essentially better, since in these are found long and complicated systems of shafting if the motive power is a single engine, and, if not, then a reduplication of the conditions found in smaller shops.

The grossest inefficiency may generally be looked for in shops having very irregular demands for power and in those employing a very large number of very small machines. Under such circumstances the fixed losses due to the belting and shafting system are, on the average, so large that the power usefully employed may be quite insignificant. A flagrant example was recently investigated abroad. The case was one in which a workshop was fitted with forty-two light machines on small mechanical work. Each machine was belted to a small countershaft. These were driven by pulleys from two line-shafts, which were in turn belted to a jack-shaft driven by a belt from the prime mover. The net power on this first pulley was 22.28 h. p., while the forty-two machines received in the aggregate 1.8 h. p. The rest was used up in the transmission. It is obvious that in a case of this sort a large amount of valuable power could be saved by abolishing the whole system of transmission by shafting and belts, and driving each machine by an electric motor.

Allowing only fifty per cent. efficiency for the motor system, including wiring, the net saving of power is 18.68 h. p. Taking the cost even at three cents per h.-p. hour, which is very low, the saving in a year of three thousand working hours would be $1,681.20, almost enough to pay for the installation during the first year under ordinary circumstances. This is a rather extreme case, owing to the large number of very small drives, but others nearly as bad can be found without looking far.

It does not follow, however, that such an application of motors to individual machines will always pay. For genuine economy it is necessary to deal with conditions in which the possible saving in power is considerable, and the cost of installation not unduly raised by the character of the load. In the instance just given the machines were

all lightly loaded, so that no single motor of more than one-third to one-half h. p. would be necessary. Cases of intermittent use may readily arise, in which the average load would be very small, although any single machine might temporarily require several horse power.

The result of this would be to render necessary the installation of motors aggregating many times the average or even the maximum load, and the system may prove too costly. Take, for instance, a plant with twenty machines, requiring together 10 h. p. net to drive, while 10 h. p. is taken up in the transmission. If each machine should require at times 5 h. p., then twenty 5 h.-p. motors must be installed, costing say $5,000. Reckoning interest and depreciation at ten per cent., the annual fixed charge would rise to $500. The efficiency could not be very high under such load conditions. Allowing it to be .66, which is a very liberal estimate, the net saving in power would be but 5 h. p., worth, at three cents per h.-p. hour, $450 per year of 3,000 hours. There would thus be a net loss of $50, even if electric power could be obtained at the low figure mentioned, which would usually be impossible. If, on the other hand, twenty 1 h.-p. motors would do the work, there would be a material annual saving in electric power.

There are, thus, numerous cases in which the use of individual motors gives no direct economy in power. Nevertheless a saving may often be effected by using electric motors so disposed as to cut off a material part of the shafting losses. Sometimes a group of machines has to be driven at a considerable distance from the engine through a rather complicated system of shafts and belts. If a single motor can be installed for this group, there will frequently be saving enough to justify the application of electric power, even if there is no gain in the rest of the plant. In the original installation of a machine plant a little tact generally renders it possible to subdivide the machines into groups which can be driven by motors with very little loss in transmission. In existing installations this advantage is not so easy to secure. One of the chief difficulties is the usual lack of knowledge which prevails regarding the actual amount of power required by a machine, or group of machines, and the losses in transmission. Even the most skilful guessing is generally wide of the mark. No safe rule can be laid down for estimating the losses in shafting, as these depend upon the number and character of the supports.

For a rough estimate, however, one will not go far wrong in allowing 3-5 per cent. loss in efficiency for each belt drive, and 1-2 per cent. for each bearing surface, whether hanger or loose pulley. A transmission, then, with, say, four belt drives and thirty

bearings, would be likely to have a total efficiency perhaps as high as 55-60 per cent.,—possibly as low as 20-25 per cent. This is very loose approximation, but quite as close as the uncertain facts warrant. The larger figure can be surpassed, if the shafting is carefully designed and kept in good order, while the lower figure may be too high for shafting badly aligned and too lightly loaded.

The power required for the driven machines is similarly uncertain. It runs from minute fractions of a horse power to 20 h. p. or more in heavy metal-working tools.

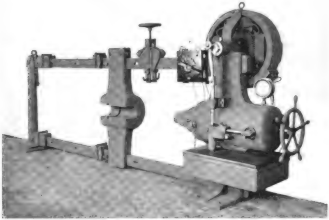
Recently some interesting attempts have been made to reduce the power required for metal working to terms of the hourly weight of shavings. The following are some of the results obtained on lathes:

	Material.	*H. P. Required.*
	Mild steel	.047 W
	Wrought iron	.0327 W
	Cast iron	.0314 W
For planers—	Mild steel	.012 W
	Wrought iron	.052 W
	Gun metal	.0127 W

W, in each case, is the number of pounds of metal removed per hour. These figures necessarily vary somewhat with the condition of the cutting edge, the character of the material, the shape of the cut, and so forth; but the general amount of the power needed is clearly shown. It takes a large lathe or planer to require more than 5 h. p., and during a great portion of the time of actual work the load is no more than a quarter or a half of this, including the friction of the machine.

It thus happens that the average load of each machine is far less than the full load, and, further, in actual machine-shop practice each machine is generally in operation only a moderate portion of the time. Therefore the average power required for the whole plant is usually considerably less than the sum of the average outputs of the individual machines while running.

This fact has an important bearing on the economic application of electric power. It is necessary not only to deliver efficiently the power needed for each machine, but to stop the loss of power when the machine stops. This condition indicates the use of individnal motors, which can be shut down to stop the machines to which they are attached. But we have just seen that such a proceeding may necessitate large motor-capacity, which increases the cost and lowers the efficiency. In any case, it is desirable to take the fullest advantage of intermittent use, and nothing facilitates this like the use of electric motors, for in every other general method of distributing



100 TON HYDROSTATIC PRESS, MADE BY THE NILES TOOL WORKS, DIRECTLY OPERATED BY ONE OF THE BULLOCK ELECTRIC MFG. COMPANY'S VARIABLE FIELD MOTORS.

power that part of the loss which is irrespective of the amount of power utilized is considerably larger.

There are, however, conflicting interests in determining just how electric power can be employed. Perhaps the best way of attacking the problem in any particular case is to take it up in sections, answering *seriatim* the following questions :

1. What is the actual average power now required at the main drive?

2. What is the actual yearly cost?

3. Can I buy the given amount of electric power more cheaply than I am producing power now?

These questions will define the existing conditions, apart from economies in transmitting the power.

The next step should deal with the transmission, and should be taken irrespective of the economy shown in the preliminary inquiries,—for one may over-balance the other.

4. How much total power is lost in shafts and belts?

This point is determined by measuring the power consumed when all the machines are off. In many cases indicating the engine very carefully is the best method of testing. Sometimes a temporary electric motor can be used for the same purpose. The investigation of these transmission losses should be as far in detail as the condi-

tions permit. By throwing off belts here and there the power required for each main shaft can be approximately estimated, or the motor can be moved from place to place with temporary leads.

Now begins the delicate part of the operation. It is easy to find the average power required when running under load, which constitutes the answer to question 5.

5. What is the average daily output?

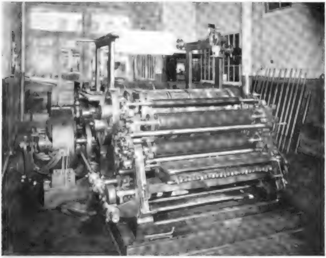
But, in order to know how electric motor power can most economically be applied, it is necessary also to know:

6. What is the average power and the maximum power demanded by each machine? and

7. What proportion of the time is each machine in operation?

The average and maximum power can be estimated for the larger machines much as the shafting losses were estimated. For small machines a temporary motor can often be arranged. These tests involve some trouble, but, if the answer to question 4 indicates the opportunity for considerable saving, they are well worth the while.

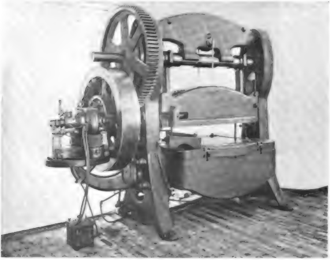
We have seen that there are two general methods of arranging motors: first, driving individual machines; second, driving groups of machines. The former is always popular on account of its neat appearance, but we have already found that it is not, under all cir-



CAMPBELL-WEBB PERFECTING PRESS DRIVEN BY A THRESHER ELECTRIC MOTOR.

cumstances, economical. It appears in two forms,—the direct consolidation of the motor with the machine, of which several admirable examples are shown, and driving the machine by a belted motor located at the most convenient point. The first-mentioned device is very neat and efficient in new installations. It is not, however, always advisable, particularly in changing over an existing plant. It must be remembered that belting is the simplest and most efficient method of changing speed, and that most tools run at so moderate speeds that something of the kind is necessary. Very-low-speed motors are apt to be little, if any, more efficient than a moderate-speed motor with belting, and are more bulky and costly. Electric machine tools are admirable in cases where space is very important, or where the speed is high enough for direct connection or so low that considerable complication in gearing is unavoidable and cannot readily be helped out by belting.

Modern motors, particularly of the induction type, are very often placed on raised platforms or brackets, so that the question of floor-space seldom has to be raised. In working over an existing plant, it is more than likely that directly-connected or geared, and ordinary belted, motors will have to be used, each being employed where it will prove most effective.



LARGE FERRACUTE PUNCH PRESS DRIVEN BY CROCKER-WHEELER ELECTRIC MOTOR.

A GROUP DRIVE IN THE CROCKER-WHEELER SHOPS.

Group-driving is very often advisable, both in old and new plants, particularly if there are groups of machines using considerable power and using it steadily. A fine example taken from mill work is shown on page 356. Here a 65 h.-p. inverted induction motor is coupled directly to the main shaft, from which are directly belted the group of cotton-picking machines. A smaller application to machine-shop work is illustrated above. Used in this way, the motor drive is highly efficient, and it is certain that as much efficiency is gained by using a single large motor as is lost by the small remaining amount of shafting and belts.

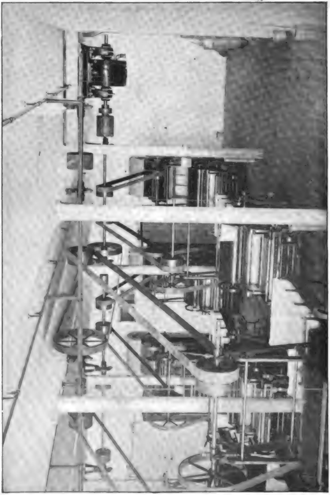
Having approximate data on the power lost in shafting and that required by the machines, the approximate saving possible by electric power can be estimated. In arranging the motor plant the following general rules may prove useful, although the varying conditions found in practice cannot be reduced to precise rules and formulæ :

1. Abolish long shafts serving simply to transmit power.

2. Abolish quarter-turn drives.

3. A group of well and steadily-loaded machines is generally best driven from a single motor.

4. Machines requiring large and intermittent power are best driven by individual motors.



GROUP-DRIVING BY 65 H.-P. GENERAL ELECTRIC MOTOR IN THE PICKER ROOM OF THE COLUMBIA MILLS.

5. Machines having small average and large maximum power can advantageously be grouped.

6. Machines driven through long intervening shafts, or otherwise disadvantageously, should be supplied with individual motors.

Rules 3 and 5 are at first sight contradictory, but in the former the group-drive gains in efficiency by the substitution of a large motor for many small ones, while in the latter it gains by taking full advantage of intermittent use. In a new plant machines can be, to a considerable extent, arranged for economical driving, but in old plants one must do the best he can with existing conditions. This usually means frequent grouping and individual motors where they will do the most good.

In large and scattered plants it often turns out that it will pay to install a central electric plant and distribute power by motors. Experience shows that in such cases one can count upon an average net efficiency of about .65 to .70, or a little more, counting from the indicated h.p. of the engine to the motor pulleys. The exact figure depends on the ratio of average to maximum load. This is, as a rule, considerably better efficiency than can be obtained by any other scheme of distributing power, and enables the power to be produced far more cheaply than would be possible if separate engines were scattered about the shops. If such a plant is built for electric driving, there is a considerable additional saving in space and in cost of shafting and belts. Even in an old plant there are few cases in which the change to electric driving will not pay a large return on the capital so invested. Of the other and often greater economies due to saving in labor and the improvement in methods of working we will speak later.

CHARACTERISTIC AMERICAN METAL MINES.

By J. Wyman Jones.

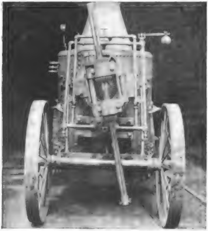
I. THE PLANT OF THE ST. JOSEPH LEAD COMPANY.

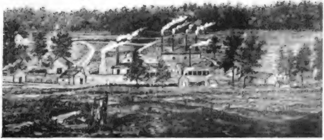
ANY one visiting the immense caverns, hewn from solid lime-rock, in the process of mining on the property of this company, located in southeastern Missouri, would require no other evidence of the magnitude of the work there accomplished.

About fifty acres of underground rooms are witnesses of the millions of tons of rock that have been blasted, broken into sizes suitable for one man to handle, hoisted to the surface, crushed, and concentrated! These rooms are sustained by columns and arches, left in the progress of the work, and vary in height from twenty to seventy feet. They are inhabited, night and day, by men drilling, blasting, and loading rock, and by sleek mules which rarely, if ever, see the day-light.

The company was organized under the laws of New York on March 25, 1864. The capital stock (a million of dollars) was issued for the nine hundred acres of land first secured, and little was done until the meeting of the stockholders held June 13, 1865. At that time a board of trustees was elected, none of whom had any practical knowledge of lead-mining; but all were determined to push the work of development. The writer was elected president on September 25, 1865, and has held the office continuously ever since.

Lead mining in Missouri was exceedingly crude at this time, though carried on to some extent in several parts of the State. Here and there surface deposits were found and


THE DIAMOND DRILL.



BONNE TERRE IN 1865.

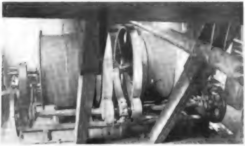
quickly worked out. Drilling was done by hand. Horizontal sheets from eight to eighteen inches thick were found in few places. No true veins had been discovered. No attempt had been made to work deep shafts. Continuous work was prevented by changes in the weather. In wet, very warm, or cold weather the open-cuts could not be worked. The disseminated surface-ores were mostly of fair quality. These were crushed, jigged, and washed by hand, and smelted in old-fashioned reverberatory furnaces, or "Scotch hearths."

After a fair trial of these unsatisfactory processes without profit, this company determined upon a more vigorous policy.

In May, 1867, the services of Mr. C. B. Parsons, as superintendent, were secured, and this able and excellent manager still remains in that position. Not long thereafter it was determined to search below

BONNE TERRE IN 1897.

the surface for deposits and to abandon surface work. A diamond drill (then first introduced to the public) was secured, a boring of 120 feet was made, and a shaft sunk. The diamond drill was the beginning of success. Once well below the surface, the work grew interesting.



THE DOUBLE HOISTER.

Drifting was commenced at the bottom of the shaft, and soon fair ore was discovered. From that day forward to the present date all mining has been done at depths ranging from 120 to 500 feet. With uninterrupted work, night and day, the output soon increased. In the thirty years which have elapsed since that day the huge caverns mentioned in the first part of this article have been blasted out, and have furnished the enormous tonnage of rock from which the lead has been extracted.

These excavations have grown naturally into their present proportions, in the course of development. They commenced with ordinary stopes, seven or eight feet in height. As drifting in these

THE MILL.

MILL, WITH TWELVE CRUSHERS AND MINED ROCK.

stopes continued, and as fair ore appeared in the top or bottom of any stope, the ore was taken out. A narrow track, about three feet wide, was laid in the bottom of each stope, and extended as fast and far as the drift was carried. All the rock was broken, lifted by hand into iron cars holding about a ton, and rolled, either by

INTERIOR OF MILL, SHOWING JIGS AND TABLES.

THE SMELTING PLANT.

hand or mule power, to the hoisting shaft. There it was lifted to the surface. The capacity of the double lift is a car for every minute in the twenty-four hours.

When working in the bottoms of these stopes, the tracks were lowered as needed, first on one side of the stope and then on the other. As the blasting of rock went on at the top of the stope, or

A TRAIN LOAD OF ORE.

at the bottom, or at the sides, the large rooms appeared in some cases from seventy to one hundred feet between roof and floor.

LYCEUM AND PUBLIC HALL.

We have considered electricity as a power in the mines, but have not adopted it underground, either for lighting or for a motive power. The destruction of wires for lighting by heavy blasting, and of engines upon tracks, and the constant necessary changes of the tracks, have been obstacles too serious. The only use we have made of electricity has been for lighting the mill and works on the surface, and for blasting with the electric battery.

We are at present hoisting from eight different shafts lying an average distance of one-fourth of a mile from each other, and varying in depth from 150 to 450 feet. The ores from all these shafts are delivered at the mill for dressing,—a part of them in iron cars drawn by mules on tracks laid in the mines, and a part by engines and cars on surface tracks.

NATATORIUM.

The ores of these mines are low-grade sulphids (Galena) associated with iron and copper pyrites, arsenic, nickel, and cobalt, and a trace of silver. The separation of these mineral substances from the ore disseminated through the country rock, and the concentration of the mineral, is an elaborate process, requiring rock-breakers, crushing rolls, sizing-apparatus, jigs, and percussion-tables. Although the ore

hoisted from the mines has seldom more than eight per cent. of lead, the result of the concentration is a product containing from sixty-five to seventy-five per cent. of lead.

Since the underground work was undertaken, the business of the company has been steadily extending. By the use of the diamond drill, the percussion drills, dynamite, double hoisters, pumps of

CATTLE BARNS AND CATTLE, BONNE TERRE FARMING COMPANY.

very large capacity, railway tracks, dump cars, improved air-compressors, and other modern facilities, the product has been increased from forty tons of pig lead a month to at least forty-five tons a day.

Notwithstanding this steady drain upon the mines, there is at present no falling off in supply. As the percentage of lead in the ore remains about the same, an immense tonnage of rock is crushed daily, averaging not less than one thousand tons!

The old styles of smelting have long been abandoned. A new smelting plant has been built on the Mississippi river, twenty-seven miles from the mines, midway between the mines and St. Louis, where all the mineral is smelted in blast furnaces.

One of the greatest obstacles in the way of a larger development was the need of better facilities for transportation. Located, as the mines are, fifteen miles from the Iron Mountain Railroad and twenty-seven miles from the Mississippi river, the company was dependent upon mule teams for moving both product and supplies, as well as ores, waste rock, and tailings. These became wholly inadequate. In 1880 the company completed a narrow-gage road to Summit, a station on the Iron Mountain Road, and in 1887 began the building of a standard-gage railway to the Mississipi river at Riverside, near the location of the smelters. This road was completed in 1890, and since then has been extended twenty-five miles southerly, and is now owned and operated by the Mississippi River & Bonne Terre Railway Company. Its cost was more than $1,100,000. It is fully equipped, passes through a splendid lead district, is fifty-two miles in length, and has proved a complete success.

This road has greatly reduced the cost of operating the mines, by the use of spurs and tracks to the different shafts, besides greatly lessening the cost of coke, coal, and other supplies, as well as the expense of marketing the product and handling tailings, etc.

From time to time large tracts of mineral and other lands have been added to the original plant, until they include about fifteen thousand acres. A new mill and dressing works (wholly of iron) have been constructed, and supplied with modern machinery.

A large number of dwellings have also been erected. Large expenditures have been made for new shafts and hoisting engines, underground pumps, etc., and the smelting plant has been built on the Mississippi river at Herculaneum. The capital of the company is now three millions of dollars. The company, previous to 1891, had developed an extensive farming business; and, as under the laws of Missouri, this use of its lands seemed questionable, the surface rights of all lands (reserving all mining rights) were transferred in that year to the Bonne Terre Farming and Cattle Company, a corporation organ-

ized to work the same. This company is now engaged in an extensive milk and dairy business.

The lead company has never suffered from a strike. It has paid good wages, and paid them promptly. Some of the present employees have continued with the company from the start—very many of them for years. An interest is manifested in all employees and their families. Good schools, churches, a free library, a hospital, etc., are maintained. A public hall, a swimming pool, and a bath-house have been built by the company.

A village of from five to six thousand inhabitants has grown up around the works, called Bonne Terre, where all the comforts and conveniences of modern life are found. This prosperous town is in marked contrast with the place as it was in 1865, and is now the centre of a thriving farming country.

There has been no conflict between the company and labor. About one thousand men have been steadily employed for thirty years.

It will be observed that the ore worked by this company is very *lean;* that immense quantities of rock have been handled; that its large product has resulted from the use of the diamond drill and other power-drills, high explosives, and most approved dressing and smelting works, accompanied by an energetic and careful management; and that a large part of the success attained has been secured by maintaining harmonious relations, through all these years, with labor.

ELECTRIC TRACTION UNDER STEAM-RAILWAY CONDITIONS.

II.

By Charles H. Davis.

IN the preceding paper on this subject, appearing in THE ENGINEERING MAGAZINE for May, 1897, the great resultant increase of revenue, under proper operative management, was shown to be frequently justification for the choice of an electric-traction system, even though its first cost and operating expenses might be far greater than that of a steam road. For the purposes of the general argument, this greater charge against the electric system was assumed. It is the purpose of this article to examine the assumption in detail, and develop a critical comparison of the two systems of installation and operation. For convenience in exhibiting their respective merits, the following divisions are arranged in tabular form, after the scheme commonly used for present steam-railway records. The prefixion of the word "electric" or "steam" indicates an item belonging exclusively to one or the other systems respectively, and having no counterpart in the other. In the discussion the same general conditions are assumed, whichever system is used.

FIRST COST:

RIGHT OF WAY AND REAL ESTATE.

CONSTRUCTION.

1. Engineering and surveying. 2. Clearing. 3. Grading, ditching, etc. 4. Tunnels. 5. Masonry, culverts, bridges, trestles. 6. Fencing, cattle-guards, road-crossings. 7. Ballasting. 8. Ties. 9. Rails. 10. Track-laying, lining, and surfacing.

(electric) 11. Rail bonding.

(electric) 12. Overhead-trolley line, or third rail.

13. Signals. 14. Telegraph. 15. Stations and all buildings (including building for central power stations of electric roads.) 16. Terminals.

EQUIPMENT.

(steam) 1. Locomotives and tenders.

(electric) 2. Motor cars or electric locomotives. 3. Passenger cars. 4. Freight cars.

(electric) 5. Electric feeder lines and ground return circuit.

(electric) 6. Central power stations (not including buildings which are considered under "Construction").

GENERAL.

1. Discount on bonds. 2. Interest on bonds to opening of road. 3. Taxes to opening of road. 4. Office expenses, salaries, etc., to opening of road. 5. Contingent and miscellaneous not itemized, to opening of road.

TOTAL EXPENSES:

MAINTENANCE AND RENEWAL OF WAY AND WORKS.

1. Repairs of earthwork to sub-grade. 2. Repairs of track. 3. Repairs of fences, cattleguards, crossings, etc.

(electric) 4. Repairs of ground return circuit.

(electric) 5. Repairs of over-head trolley line, or third rail.

(electric) 6. Repairs of electric feeder lines.

7. Renewals of rails. 8. Renewals of ties. 9. Renewals of ballast.

(electric) 10. Renewals of poles, or insulation of third rail.

(electric) 11. Renewals of trolley, or third rail.

(electric) 12. Renewals of feeders.

13. Repairs of masonry, bridges, trestles. 14. Repairs of buildings. 15. Repairs of signals.

TRAIN EXPENSES.

(steam) 1. Fuel for locomotives.

(electric) 2. Fuel for power stations.

3. Water supply. 4. Oil and waste.

(steam) 5. Repairs and maintenance of locomotives and tenders.

(electric) 6. Repairs and maintenance of motor cars or electric locomotives.

7. Repairs and maintenance of passenger cars. 8. Repairs and maintenance of freight cars. 9. Use of foreign passenger and freight cars.

(steam) 10. Locomotive services (wages).

(electric) 11. Motor car or electric locomotive services (wages).

12. Passenger train services (wages). 13. Freight train services (wages).

(electric) 14. Repairs and maintenance of power stations.

(electric) 15. Power station services (wages).

STATION, TERMINAL, TAXES, AND GENERAL EXPENSES.

1. Agents and station services (wages). 2. Station supplies. 3. Telegraph. 4. Taxes. 5. General officers and clerks. 6. Legal. 7. Insurance. 8. Stationery and printing. 9. Agencies and advertising. 10. Contingent and miscellaneous not included above.

ACCIDENTS, LOSS, AND DAMAGES.

1. To freight. 2. To passengers. 3. To property owned. 4. To property not owned.

INTEREST ACCOUNT.

FIXED CHARGES:

1. Interest on bonds. 2. Rentals.

GROSS RECEIPTS:

1. Passenger receipts. 2. Freight receipts. 3. Miscellaneous receipts.

The first cost of "right of way and real estate" for the same traffic, location, and similar general characteristics is the same; the only advantage electric traction seems to have is the saving which might come by greater flexibility in alignment, due to ability to more easily surmount heavier grades; this advantage is more imaginary than real, for electricity is limited to suburban traffic and short lines, where the additional cost to avoid heavy grades is of small moment; if they are not avoided, the loss of time would doubtless result in corresponding loss of revenue.

In "construction" account we find that items 11 and 12 apply

to electric traction only, while there are no items applying to steam locomotive traction only. These items might have been placed under the heading "equipment," as part of the things necessary in electric traction to replace steam locomotives, and which could be added to motor cars or electric locomotives as equipment for an electric road; this phase of the question will be discussed under the heading "equipment." The engineering of an electric line might cost more than that of a steam road, but not necessarily; if the chief engineer was a competent railroad man with a thorough knowledge of electrical engineering, the cost would be the same; otherwise it would be increased by that amount paid an assistant engineer with special electrical knowledge, unless the line was costly enough to warrant several assistant engineers, one of whom could be versed in electrical matters. The cost of surveying work, consisting of reconnaissance, exploration line ("shoo-fly"), preliminary, location, and their modifications or extensions, depending upon the importance of the line, its cost, character of city and country, etc., would be the same in either of the cases under discussion for any specific example. The cost of clearing, grading, ditching, tunnels, masonry, culverts, fencing, cattle-guards, and those parts of the system pertaining to these general items, is not affected by the choice of system. It might be thought, at first, that the cost of masonry would be affected, if lighter bridges and trestles could be used with electric traction, but the weight and size of masonry abutments, piers, footings, etc., would hardly be affected by any slight changes in the moving load, for they are much more dependent upon the weight of earth embankment that they support and the character of ground they are built upon, together with their height and length. If they perform all their other functions, according to the best engineering practice, they will usually be found far more substantial than theoretically they need to be in order to uphold the weight of the super-structure. The cost of road-crossings will be the same, except where the third-rail electric system is used; should the third rail be broken at a grade crossing (the present practice of the New York, New Haven & Hartford R. R. Co.), the cost of such crossing will not exceed the cost of those used on steam roads; but this makes an imperfect system, both as to continuity of power and lighting circuits. No highly successful means have yet been devised to overcome these difficulties, but, if they are ever properly solved, crossings will be more costly on third-rail electric roads than on steam railways. In the design of bridges and trestles the principal elements which determine their cost are the span, dead weight, live uniform load, concentrated live load at head of trains (locomotive and tender), the speed of trains, and the "ham-

mer-blow" of the reciprocating parts of a steam locomotive, especially when it coincides with the period of oscillation of a bridge (very objectionable on bridges which are too light); electric motors, either geared to the axles or gearless (concentric with the axle), have a rotative motion, and therefore do not produce the effects of the "hammer-blow" referred to above. Owing to the peculiar construction of the electric locomotive or motor car, a greater proportion of the total weight is on the driving wheels than is the case with steam locomotives; therefore, with the same tractive effect (weight on drivers), the use of electric locomotives or motor cars reduces the moving weight at head of train; the weight of tender is saved by the use of electricity. These three facts would theoretically enable bridges and trestles to be built lighter for roads using electric motors, providing the loads were not concentrated upon a smaller wheel base, were it not for the fact that the necessity of providing for constantly increasing weights practically offsets the theoretical saving which might be made. Were it possible to operate trains where every car was a motor car, the cost of bridges and trestles could be reduced. The cost of ballasting, ties, rails and track-laying, lining, and surfacing will be the same in either case (drilling rails for bonding is covered by item 11), although a small saving in maintenance of these items is possible for electric traction (discussed under "total expenses"), which indicates that the first cost could be reduced for the same cost of operating; yet, as this would be poor economy, the quality, weight, and general character should be the same in either case. By the use of electricity it might, at first, appear that the signal and telegraph system would be reduced in first cost; the only possible saving would be in the source of the current used, which forms so small a percentage of the whole that for our purposes any difference can be neglected.

Stations would cost the same under similar conditions, whether steam or electricity were used, while all other buildings, including the power houses of an electric system, would be equal in cost, whatever the system; although the electric road requires buildings for its centralized motive-power plant (that is, all but the transmission line and motors) which are not a burden on the steam road, yet these are no doubt balanced by round houses, coal stations, water stations, and the larger machine shops required for steam-locomotive repairs. Terminals will cost the same, whichever system is used. So far we have found that the first cost of construction is substantially the same, whether steam locomotives or electric motors are used, but, if the latter are adopted, some additional work is necessary,—namely, (11) rail bonding and (12) over-head trolley line, or third rail. It will at

once be seen that these items add considerably to the cost of construction of an electric road as compared with that of a road operated by steam locomotives.

As an example, which will show, in a general way, the increased cost of electric-traction construction, let us assume, without any pretension to exactness, that the line is single track, one mile long; average speed of trains (including stops), twenty miles per hour; headway, one minute; length, six cars (one being a motor car); total weight of train, two hundred tons when loaded to ultimate capacity; rails, ninety pounds per yard; average nominal horse-power, 300 per train, (will exert 450 h. p. or even more, if required, for short periods); total maximum average nominal horse-power per mile of track (one way) at above headway, 900; average loss in transmission, 20 per cent.; assumed average nominal horse-power at station, 1,125 (allowing for loss and including surplus power), located at one end of line. With these assumptions, we have the following approximate additional cost for construction, if electricity is used. The electric return circuit would consist of the two lines of rail properly bonded with copper wires; two 4/0 B. & S. G. wires to each rail joint, which would cost to-day (copper, 15 cents per pound), complete in place, including terminals and drilling rails, 70 cents each bond, or a total of $497. To this must be added cross bonding of lines of rails, which varies much in practice; for our case, we assume that this is unnecessary, if the bonds at joints are properly made and maintained with the care displayed on other parts of the system. Over-head trolley line would be of iron poles, centre construction (assuming that there would be a double track); trolley wire, 423,200 circular mills; poles set every 100 feet, each weighing 1,300 pounds (30′ × 8″ × 7″ × 6″) set in concrete, would cost for one mile, approximately, $3,237 (1/2 of poles with brackets and feeder supports, etc., set at $50.00 each; trolley 6,748 pounds at 15 cents, special line material, $500; labor, $400).

To recapitulate, one mile of track equipped electrically will cost:

(11) Rail bonding. In this case the cost of ground return circuit is not an extra cost against the electric road, for the rails are used, they having sufficient capacity to carry the current:—see "Equipment."	$ 497
(12) Over-head trolley line	3,237
Total extra per mile for electric road	$3,734

Under "equipment" we have eliminated freight cars (item 4) as already stated. Passenger cars would cost the same, electric lighting

and electric heating of one being balanced by gas and steam heat of the other. Should motor cars be used, carrying passengers, there would be a saving equal to the cost of one passenger-car per train in favor of the electric road. If an electric locomotive were used, there would be no such saving. If every car were a motor car, then the cost of a steam locomotive per train would be saved in the case of electric traction; this, however, would add to the cost of each car. The system is not possible to-day, though we hope it may be in the future. Steam locomotives and tenders are to steam roads what motor cars (or electric locomotives), electric feeder lines and ground return circuits, and central power stations (without buildings) are to electric railways. To show the relative costs, let us again consider the former example. Feeder line would be about two 4/0 B. & S. G. wires of bare copper, as the company owns the right of way, and crossings of public highways at grade are unlikely on roads of the character we are discussing; these would cost in place $1,117 ($1,012 for copper and $105 for stringing). It will be noticed that the trolley wire suggested is much larger than that used in general practice, and, as it has large carrying-capacity, part of its cost might have been included in the cost of feeders. It is unnecessary here to go further into this question. In our example the area of copper in the overhead system is 846,400 c. m. (circular mills), equivalent to 920 mills diameter, which gives a total cross-section of .657 sq. in. A 90-pound rail has an area of 9 square inches, cross-section; taking the relative conductivity of steel and copper as 1 to 6, we find that each rail is equivalent to 1.5 square inches of copper, and both rails to 3 square inches; therefore, until the over-head system had a cross-section of more than 3 inches, there would be no necessity of any copper ground return circuit, so long as the bonding section at joints was the same as that of the over-head work. In case the area of both rails divided by 6 is less than the area of over-head copper, the copper ground-return wire should be of that section equivalent to the excess in section of over-head copper. This ground return can be run on the pole line and connected down to the rails at intervals or along the track, as may seem best in any given case.

The central power station of 1,125 nominal h. p. could be erected complete (without buildings included under "construction") for $50 per horse power, which would provide a plant of the most modern kind, giving the greatest economy (in the largest sense); in general, it would consist of steel stack lined with fire-brick, water-tube boilers, pumps, piping, condensers, heaters, blowers, direct-connected corliss engines, direct-connected generators, slate switch-boards, best indicating and recording instruments, etc., with all the

best labor-saving and automatic devices which help to make a thoroughly successful plant. The total cost of power plant would be $56,250. We shall not discuss the use of an electric locomotive, but assume the use of motor cars drawing trailers. In the estimate of 200 tons as the weight of a 6-car train, one being a motor car, the car bodies assumed are 45 feet over sills, 51 feet over all, with two trucks having four wheels each, the wheels being 33″ in diameter; car body weighing 22,000 pounds, trucks, 13,000 pounds; total, 35,000 pounds; average maximum passengers, 150 at 150 pounds each, 22,500 pounds, making total weight of passenger car loaded 57,500 pounds. The motor car is assumed to have four motors, one on each axle, or geared to it, its total weight loaded being 112,500 pounds (56.25 tons loaded, 45 tons empty, all on drivers). The trucks of this motor car would be heavier than the trail cars, and with larger wheels. With two four-wheel pivotal trucks, the weight on each driving-wheel would be 14,082 pounds, loaded, and 11,250 pounds, empty. The trail cars can be assumed to cost, complete, for steam or electricity, about $3,500; the motor car complete, about $7,000. A steam locomotive and tender of the same power and tractive force would cost about $9,000 (engine, $7,700; tender, $1,300). It will be noticed that the heating of cars has had no consideration in this article; while this would add to the first cost of an electric system in increasing the required capacity of transmission line and power house, and would undoubtedly add to the cost of operating as compared with steam locomotive practice, yet available data are so unreliable that a discussion of them is postponed. To recapitulate, on the basis of our example, we have the following additional charges against electric traction:

Feeder line	$ 1,117
Ground return (in this case no additional cost)	
Central power station	56,250
	$57,367
Deduct difference between 3 motor cars and 3 locomotives and tenders	6,000
Total per mile	$51,367

To estimate a ten-mile road at ten times the above would be unfair, for, unless the train density remained the same on every mile and a power station were built for every mile, it could not be in direct proportion; in general, the feeder system increases in cost as the distance, while the power station increases in cost as the weights moved and their speed. There would undoubtedly be found conditions of

very light trains at very frequent intervals over short distances where the larger cost of locomotives and tenders would balance the items which usually make the use of electricity the more costly; these conditions must more nearly approach those which now exist in street-railway service.

"Electric feeder lines and ground return circuit" is placed under the heading "equipment" rather than under "construction" for the purposes of this article; in a system operated by electricity the opposite course would be pursued, and has been followed in considering "total expenses." "Central power stations" (all but buildings) would naturally be in the motive power department, and are so considered in this article.

"General" items of "first cost" would be unaffected by the character of the system; a few years ago, when the word "electricity" as applied to street railways was more attractive in banking and investing circles, higher prices for bonds might have been obtained by the use of that system, but elements of this kind are not within the scope of this article. Taxes are based on value, not on cost, and are therefore unaffected by any particular system.

TOTAL EXPENSES.

We have adopted the title "total expenses" in a literal sense, including all expenses of every kind, so that the difference between "total expenses" and "gross receipts," if on the right side, would give the amount which can be considered the actual net earnings of the line. "Operating expenses," which are generally treated as the usual and ordinary expenses of the system, include "maintenance and renewal of way and works," "train expenses," "station, terminal, taxes, and general expenses," and "accidents, loss, and damages," but not "fixed charges," although the latter form a great percentage of the actual total expenses, and have become a necessity in our industrial and financial development. The operating expenses include many items which do not vary with the amount of business or the character of the alignment,—such as salaries of leading officials; maintenance of way, works, and parts of the system, against that deterioration which is produced only by time, irrespective of the amount of business handled or work done; salaries of agents of all kinds, many of whom have to be employed whether business is large or small, etc. All of these might be called the "fixed operating expenses," and, as they often amount to nearly half of the total operating expenses, it will prove instructive and remunerative to keep railroad accounts so as to show this. To reduce the total expenses to the minimum consistent with true economy is as important as to reduce the first cost to the lowest amount, bearing the same axiom in mind. We will now consider

"total expenses" in detail, following the order of the tabulated statement.

First comes "maintenance and renewal of way and works," and the subdivisions under it. "Repairs of earthwork to subgrade" would be unaffected by the system used. Repairs of track, fences, cattle-guards, crossings, etc., renewals of ties, and ballast are substantially independent of the volume of traffic; ties wear independently of the tonnage, for the so called "cutting" of ties is due primarily to the rotting away under the rail foot, accelerated somewhat, but almost inappreciably, by the decayed material cut away by passing loads. The total cost of track labor is affected only a very small percentage of the whole by any change in the amount of traffic, provided the standard of maintenance is not increased; rail-renewals, track-watchman, and part of the labor of lining, surfacing, etc., directly applicable to the track itself, are the only items which vary directly with the number of trains. One-half to three-fourths the wear of steel rails is caused by the locomotive, and is due more to the great concentration of load on the driving-wheels, which often nearly approaches the ultimate crushing resistance of the rail, than to the "hammer-blow" of the reciprocating parts. Maintenance of crossings would be unaffected by the system used, except possibly in the case of the third rail, already considered under the heading "construction." For the reasons enumerated above, items 2, 3, 7, 8, and 9 would be unaffected in cost of maintenance, whichever system were used. Maintenance of bridges and trestles should be slightly less with the use of electric motors, because of less vibratory effects; maintenance of masonry, buildings, and signals would not vary in cost with change of system. We find under "maintenance and renewal of way and works" that there are no items exclusively applicable to steam-locomotive practice; but there are six which apply to electric traction only. This naturally arises from the fact that these items occur under "first cost," and must be maintained. They are: maintenance of (4) ground return circuit, (5) over-head trolley line, or third rail, (6) electric feeder lines, and renewals to (10) poles or insulation of third rail, (11) trolley or third rail and ground return, and (12) feeders. The maintenance and renewals of these constitute an increase in the total expenses of an electric road over those of a road operated by steam.

The next division is that of "train expenses." We omit discussion of freight items, for reasons already given. The relative consumption of coal by steam locomotives and motor cars (electric locomotives are not considered), while of importance, is not so large a percentage of the operating expenses as is usually imagined; as a

rule, the attempt to save in fuel account has had more attention on electric roads than was warranted, and has been made at the sacrifice of other and more important items (for greater details see article by the author, entitled "Comparative Economy in Electric Railway Operation," published in THE ENGINEERING MAGAZINE, March, 1897). Omitting results obtained from compound locomotives, the records of which are not yet as extensive as those for single expansion, but which should show an average saving of approximately 20 per cent., it has been found that in steam-locomotive practice, of the character we are discussing, the coal-consumption per passenger-car-mile (exclusive of engine) averages about 6.5 pounds for cars weighing 20-25 tons on way-trains or 30-35 tons on through trains, and that about an average of one pound is added per car-mile for each 6 tons' added weight of car. The average coal-consumption of a passenger engine (say 40-45 tons) is about 20 pounds per locomotive mile; if we assume 6 cars to a train, as per our example, we have 3.3 pounds per car-mile for the engine and 9.8 pounds per car-mile for the whole train, including engine; this conforms to present average practice of steam railways. In the article referred to above the average coal-consumption per car-mile, under the best conditions of electric street-railway practice, is found to be about 8 pounds; the average weight of these cars, loaded, cannot exceed 8-10 tons, so that our six-car train would consume 48 pounds per train mile for a maximum weight of 60 tons and average speed certainly not exceeding 10 miles per hour; while with our steam train the consumption would be 58.8 pounds per train-mile for a maximum weight of 200 tons and average speed of 20 miles per hour. The great difference in coal-consumption per car-mile in present steam-railway and electric-street-railway practice, so much in favor of the steam road, is no doubt partly due to lower efficiency of the complete motive-power plant of the electric road (station, line, and motors), but most largely to crude controlling devices on cars, poor track, sharp and poorly laid curves, steep, uncompensated grades, and the poor class of labor employed. Average practice gives about 5.5 pounds of coal per i. h. p. per hour in steam locomotives, but the character of the service makes it liable, in any given run, to enormous variations. At times this figure is very much exceeded, and also often falls, under favorable conditions, to 4.5 pounds. The conditions which produce so large fluctuations in steam-locomotive service do not exist in the central power station of an electric road. In the latter case we cannot safely figure on less than about two and one-half pounds of coal per i. h. p. per hour. This may be reduced in exceptional cases, but will more often be exceeded. Apparently this is a decided saving in favor of the electric

road, but it is only apparent. Let us assume the following efficiencies, which are fair averages: engine, 90 per cent.; dynamos, 90 per cent.; line, 80 per cent.; and railway motors, 75 per cent (in considering these figures it must be remembered that most of the time the larger part of the system is running considerably below its rated maximum point of economy; some engineers might place motors at 80 per cent.), making the combined efficiency of the entire system about 48.6 per cent. It therefore appears that, for a given average horse-power required at the driving-wheel to move trains, double that amount, or, for safety, even more, must be placed in the central power station, making the coal consumption 5.1 pounds per i. h. p. per hour at the motor car, which is but little better than the average of single-expansion steam-locomotive practice, while it is probably no better than compound steam locomotives will give. The cost of handling coal would be substantially the same with either system, as there would be only one coaling station in either case. The cost of water would undoubtedly be greater in steam-locomotive practice, where it must be supplied at various points along a long line; but on short suburban lines, to which our discussion is limited, the steam locomotive could make a round trip without requiring water, or would have to be supplied only at each end of the line; and, as the central power station would use much more water on account of larger horse-power and the use of condensing, it is hardly likely that there would be any great difference between the systems. The use of oil and waste on the motor cars should be much less than that which is necessary for the proper care of steam locomotives; electric motors can have their wearing parts run in oil boxes, which are a protection against dust and dirt and automatically lubricate the surfaces subjected to friction, but this cannot be done in the case of steam locomotives. This saving in an electric system is, however, counterbalanced by the use of oil and waste in the central power station, so that it is unlikely that there would be much, if any, difference. Repairs of passenger locomotives and tenders on steam roads average from 4 to 6 cents per mile, with about 1.5 cents to be added for repairs to tools, shops, machinery, etc., properly chargeable to "motive power repairs." Statistics of electric roads are very imperfect and unreliable on matters of this kind, not only because such roads have usually been operated by those familiar with horse traction and having little mechanical knowledge of or inclination towards the precise methods of steam-railway management and operation, but because of the constant change of apparatus long before the old had given the life which could reasonably be expected of it as a piece of mechanism.

Even if we had such data as we might wish from existing electric

roads, they would be only indications of what might be expected on a system similar to the one under discussion. The total operating expenses per car-mile of electric street railways vary to-day from about 9 cents to 20 cents, and for our purposes we can assume that an electric road, built on its own right of way and operated under circumstances somewhat similar to those of a steam railway, but with the present equipments of our electric roads, can be operated at a total cost of about 13 cents a car-mile. In comparing repairs and maintenances of motor cars with those of steam locomotives, we must consider not only the motor cars themselves, but the power house (and the transmission line, had we not placed this under another heading). Of the above total about 3 cents is chargeable to total repairs of motor cars and central power house (.005 cents to central power house and .025 cents to motor cars), to which might be added three-quarters of a cent for transmission line. When we remember the small horse power involved, and the light weights and low speeds, it is hardly likely, with the large increase in these necessary under steam-railway conditions, that the cost of repairs and maintenance of the motive power of an electric road will be any less than that of a steam road. It is to be regretted that more reliable and extensive data are not obtainable. Repairs and maintenance of passenger cars would be the same in either system. The item "use of foreign passenger cars" is the rental paid for the use of cars of other roads while retained, and of course would be unaffected by the use of any particular system. While the operation of a motor car involves far less labor than that of a steam locomotive and its tender, yet the danger that the operator might be incapacitated makes it necessary to have two men at the head of the train, although one man would easily be able to do all the required work. As it takes two men to run the ordinary passenger locomotive, there would be no advantage of one system over the other. It would be a mistake to save wages by utilizing a lower degree of intelligence or skill for motormen and their assistants than is now used for engineers and firemen on steam railways; the tendency to do this has cost electric-street-railway owners many thousands of dollars,—more, in fact, than is usually realized. Passenger-train service would not be affected by the use of one system or the other. Central power station service is an additional charge against the electric road.

We now come to "station, terminal, taxes, and general expenses," divided into ten subdivisions, none of which are affected by the character of road-bed, rolling stock, or mechanical apparatus of any kind, but which are dependent upon the character of the business handled and its volume; therefore these items are unaffected by the

use of any particular system. The same statement applies to the division, "accident, loss, and damages," and to "interest account."

"Fixed charges" include interest on bonds and rentals; the actual rate of interest on bonds is not affected by the system used, except in ways beyond the scope of this article. We have shown that the first cost of an electric system is considerably greater than that of a steam-locomotive road (except in one special case); therefore the fixed charges will be much higher (assuming of course that the cost in each case is covered by bonds). This is no inconsiderable item, as the average fixed charges of our present steam roads are not less than twenty per cent. of the gross receipts, and, if this is largely increased by the use of electricity, it is more of a burden than can be overcome by inconsiderable savings in items of operating expenses (if such savings are even possible), such as slightly lower coal consumption, motor car repairs and maintenance, bridge repairs and maintenance, track repairs and maintenance, etc., which may be claimed in favor of electricity by some ardent advocates, irrespective of the intrinsic merits of any given problem.

In considering the total expenses of both systems, we have shown that the following would be additional charges against the electric road over those of a steam railway: renewals and repairs of transmission line; interest on bonds to pay additional cost of electric road (omitting probable excess of motor car and power house repairs and maintenance above those of steam locomotives). We have also shown that they would not be inconsiderable, especially the interest charge. These are items of sufficient importance to necessitate a very careful study of each individual problem before deciding upon a change, or even an original installation; but the great increase in gross receipts and in net revenue may, and very often will, decide the question beyond any possible doubt in favor of electricity, always remembering that the adoption of electric traction means a corresponding adaptation of operative methods, and not the mere application of a special form of motive power.

DEEP WATERWAYS FROM THE GREAT LAKES TO THE SEA.

By Allan Ross Davis.

THE annual passage of some twenty-five million tons of freight along the St. Clair river—the sole water avenue between the great northwest and the Atlantic seaboard—as well as the prospective increase of the carrying trade on the Great Lakes from year to year, demanding enlarged and cheaper transportation facilities, renders any attempt to provide an alternative route of the utmost importance to the commercial interests of the United States and Canada.

The movements of the deep waterways commissioners appointed by the respective governments are, consequently, being closely watched, and the result of their investigations is anxiously awaited.

In the meantime, in addition to the several schemes already advocated from an American standpoint for the solution of the problem, three Canadian schemes have been submitted, having for their object the construction of a shorter alternative route across the province of Ontario to connect Lake Huron with Lake Ontario and the St. Lawrence, and thus avoid the southwest peninsula and the Welland canal. These are:

(1) The Montreal, Ottawa, and Georgian Bay canal.

This route follows the line of the Lachine canal and the Ottawa river with its system of canals to the city of Ottawa, a distance of 110 miles, thence continuing 200 miles further up the Ottawa to its confluence with the Matawan river from the west, up which the ascent will be made to Lake Nipissing, 40 miles in length and an average of 15 miles in breadth, and thence descending from this summit level by the French river to the east shore of Georgian bay. The total distance from Montreal to Georgian bay through this depression in the earth's formation is 430 miles, of which the government engineers have reported 400 miles to be navigable for vessels of a considerable size. The rest of the distance of 30 miles requiring canals has been already partially completed,—that portion between Ottawa and Montreal,—leaving but 15 miles of canal to be constructed to complete the link. The cost of this undertaking, it has been estimated, would not exceed fifteen million dollars, affording nine feet of water.

(2) The Hurontario ship canal.

This is a Toronto project to construct a canal from Lake Ontario

at Toronto to Lake Simcoe 35 miles north, thence traversing the latter some 30 miles to Orillia, to descend to Georgian bay by a system of locks and dams down the 40 miles of the circuitous Severn river; or by cutting a channel directly across country for 13 miles to the same objective point. The western terminus of this route is about 100 miles south of the mouth of the French river, the terminus of the former route. The supplying of water for the increasing demands of the city, and of electric light and motive power for manufacturing and locomotion purposes, are important features of this Toronto canal scheme. Surveys have been made and approximate estimates submitted, which, it is claimed, justify the immediate carrying out of this extensive project. Toronto, however, is not anxious to turn over the source of its future water, light, and power supplies to a private corporation. Hence the Hurontario ship canal scheme has not made any material progress since its inauguration.

(3) The Trent canal.

This project had its inception in the early part of the century, when the English government was assisting her struggling Canadian colony in the settlement of the remote regions beyond tide-water. The Trent navigation system was an important link in the project to open up a military and commercial highway from Montreal to the Great Lakes at that period. The rapids of the St. Lawrence were too formidable and the Niagara barrier too stupendous to allow nature's route from the upper lakes to tide-water to receive serious consid-

SCENERY ON THE ROUTE OF THE TRENT CANAL.

ON THE LINE OF THE TRENT CANAL.

eration. A back-door route was, in consequence, adopted. The Lachine, the Ottawa river canals, and the Rideau canal, 126 miles from Ottawa to Kingston, were then constructed. Reaching Lake Ontario at Kingston, the government sent its engineers ahead up the Bay of Quinte 80 miles, with instructions to examine one of its northerly arms, the Trent river, and the chain of lakes extending to the northwest, down which Champlain returned from Lake Huron some two hundred years before, on his memorable expedition into the unknown west. It is worthy of note that Champlain ascended from Montreal *via* the Ottawa river and Lake Nipissing to Lake Huron, along which canal route (1) now follows, and descended *via* the chain of lakes and rivers now under consideration and forming the route of the Trent canal. The government engineer, N. H. Baird, M. I. C. E., subsequently submitted his report, with accompanying plans and estimates of the necessary work to be done between the Bay of Quinte and Georgian bay.

This original plan of the route, dated 1836, and entitled "Diagram of the Water communication through the Home and New Castle Districts from Lake Huron to the Bay of Quinte," though yellow, torn, and soiled, is still frequently referred to by the engineers of the Trent canal. Baird's estimate gave the total distance as 171 miles, with rise and fall of 707 feet, and a cost of £495,515. The report being favorable, an appropriation was at once made by the English government, and work began at the Bay of Quinte end.

The rebellion of 1837 interfered with the continuance of the work. After the completion of some short sections of canal, operations were suspended, and the appropriation devoted to quelling the rebellion which W. L. McKenzie had succeeded in stirring up. The engineer's report shows a continuous profile of the Rideau canal, the Bay of Quinte, and the Trent canal. This, without doubt, was the government canal route favored in those earlier days to connect the east with the west. No sooner, however, was the Rideau canal completed than the government saw that it was inadequate for the increase of traffic.

The St. Lawrence river system of canals was now deemed necessary, and construction thereon was energetically begun. Then, too, the influence of the prosperous Welland peninsula became felt in parliament, and the advocacy of the Welland canal, to connect Lake Ontario with Lake Erie rather than with Lake Huron, was zealously carried on. The sparsely-settled district contiguous to the interior Trent canal could not command the political influence of its populous frontier rival. The Trent canal was consequently side-tracked, and the construction of the Welland canal begun.

Nearly half a century elapsed before the advocates of the Trent canal, now grown numerous and commanding several important constituencies in central Ontario, could get the ear of the government. Meantime the other canals had been completed, the confederation of all the provinces into a compact dominion had taken place, and a new

ON THE LINE OF THE TRENT CANAL.

government had been elected, destined to hold the reins of power for eighteen years.

The people interested in the Trent canal now made emphatic demands for the carrying out of the original project. Canada's late premier, Sir Charles Tupper, then minister of railways and canals, personally inspected the Trent canal route, and reported favorably. Operations were begun by the construction of several excellent locks and dams in the interior, connecting a series of lakes of considerable proportions, but no extended sections of the canal were placed under contract.

The government did not feel disposed to take any more steps in this direction than became absolutely necessary, owing to the fact that the country, as a whole, looked upon the project as a useless expenditure of money. It was a freely-discussed question in parliament, and had many strong opponents. A dozen constituencies bordering thereon, whose representatives for the most part were government supporters and ardent promoters of the canal, could not, however, be thrown overboard.

TRENTON, ONT., AT THE MOUTH OF THE TRENT CANAL.

The general election of 1891 was approaching, and some tangible evidence of the government's intentions was demanded. The premier, Sir John A. MacDonald, appointed a commission consisting of two prominent engineers, Frank Turner and John Kennedy, and Judge J. A. Weller, to "consider the question of further extending the line of water-communication between Lake Huron and Lake Ontario, and to determine whether any local works are necessary, and whether it is advisable that an extension of the main works should be undertaken, and, if so, to what extent."

This report, dated Montreal, December 17, 1890, after touching upon a variety of phases of the subject, concludes as follows: "In the opinion of the commissioners, a waterway would thereby be made

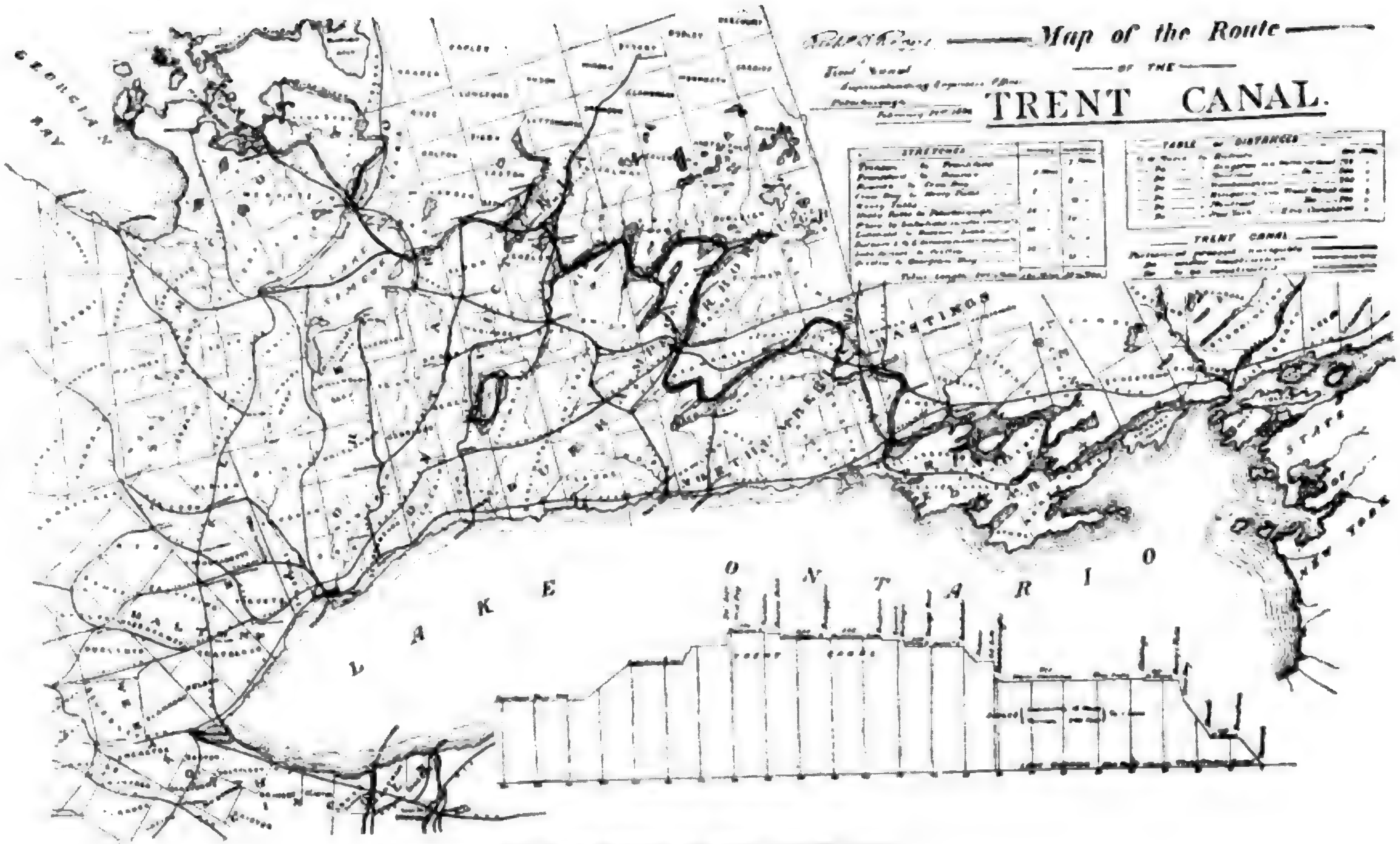
which would not only greatly increase the value of the works already constructed, but would assist and develop the industries along its route, and open up the resources of the country through which it would pass to such an extent as to amply compensate for the expenditure necessary to be incurred, though the work itself would not be expected to produce direct revenue. This conlusion is arrived at by a careful consideration of the evidence adduced before the commission, by which the commissioners feel they must be guided, such evidence in their minds greatly preponderating in favor of the extension of this important work in the manner indicated."

The favorable report of the commissioners, coupled with the announcement that the government, if sustained, would prosecute the work to completion, did excellent service in the general election immediately following. The Conservative government was sustained, and a solid body of government supporters from the Trent canal country were returned. A deputation several hundred strong proceeded to Ottawa to enforce their mandate by obtaining a definite assurance of the completion of the work. A government appropriation was now made, surveys were begun, and in 1894 two sections were placed under contract, followed by a third section in the succeeding year. Tenders were called for still another section, and several new surveys of additional portions were made during the past summer.

Everything looked favorable for the speedy completion of the Trent canal by a government fully committed to the great enterprise; but on June 23, 1896, one of those events occurred that frequently interfere with the plans of all governments. After a tenure of office of nearly two decades, the conservatives were defeated, and a new government took charge of the country's affairs, not committed in any way to the construction of the Trent canal, or indeed favorably disposed towards the project. Its first act in reference to this work was to withdraw the contract for which tenders had been asked, and to stop the surveys of all new sections. The sections under contract will be completed, but the further extension of the work at the present time depends upon a future decision, to be based, it is declared, upon two points: (1) whether the Trent canal is an actual necessity; (2) whether the financial condition of the country would justify the expenditure, if its construction be found advisable.

In accordance with this declaration, the new minister of railways and canals, Hon. A. G. Blair, made a personal examination of the route, and the work under construction, during the past autumn, in order to be able to lay the matter intelligently before his colleagues; and there the matter rests at present.

Having glanced at the political history of this government under-



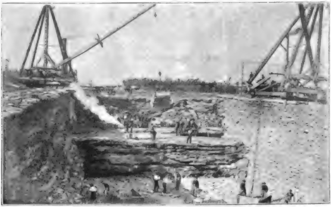
MAP AND PROFILE OF THE TRENT CANAL.

taking, we will now briefly examine the chain of lakes and rivers which the Trent canal location follows through Ontario, the extent of the work already completed, and the amount yet to be performed.

Reference being made to the heavy line on the above plan which indicates the Trent canal, it will be observed that the latter begins at Waubaushene on Matchadash bay, the most easterly extremity of Georgian bay. Midland, ten miles to the west, the terminus of a branch of the G. T. R., affords excellent harbor accommodation at the entrance. Two routes have been surveyed from this point to Lake Simcoe, between which bodies of water there is a difference in elevation of 136 feet. The first is an almost direct line to Orillia, to be obtained by cutting a canal 13 miles long. The second follows the winding of the Severn river, with high, rugged banks, swift rapids, and numerous lake expansions. The country is partially wooded, and the scenery for the most part picturesque and wild. The river route was surveyed during the past summer, and a group of excellent scenic views taken during the progress of the work.

ON THE SEVERN RIVER. ENGINEERS WORKING ON THE CANAL SURVEY.

From Orillia the route crosses the northerly part of Lake Simcoe to the mouth of the Talbot river, a navigable stretch of 16 miles. This great inland lake is surrounded by an excellent farming community, with the thriving towns of Barrie and Beaverton upon its borders. The valley of the Talbot river is thence followed in the ascent to Balsam lake, as far as Kirkfield, little or no work being required for the first few miles, on account of the possibility of flooding



CONSTRUCTION WORK ON THE TRENT CANAL.

the narrow valley. This section was withdrawn from contract when the present administration came into power. From Kirkfield to Balsam lake a canal is under construction, principally through a limestone formation.

Mr. Onderdonk, the well-known contractor, has the heavy rock excavation nearly completed on this section. The distance from Lake Simcoe to Balsam lake is 20 miles, and the rise in elevation 122 feet. This section is known as the "height of land" or summit-level of the Trent canal route. Balsam lake, the highest water-level, about five miles wide and eight miles long, with its northerly arm, Gull river,

ROCK CUTTING, BALSAM LAKE SECTION, TRENT CANAL.

extending far back into the lakes of Haliburton, is connected with Cameron's lake by the Rosedale river, a narrow, shallow stream, where considerable work is being done in straightening the course and deepening the rocky bed.

Cameron's lake is somewhat smaller than the former, and has a feeder in the Burnt river, a stream of considerable size extending into the northern timber regions. The descent of 36 feet from Cameron's lake to Sturgeon lake is overcome by locks at Fenelon falls,—a modified Niagara. Here the River Scugog extends twenty miles to the south to Lake Scugog, passing through the prosperous towns of Lindsay on the river and Port Perry on the lake. A lock has been constructed at Bobcaygeon, giving access to Pigeon, Buckhorn, and Chemong lakes. From thence the lock at Buckhorn leads to Deer bay, while those at Love Sick and Burleigh give access to Stony lake, the total fall being 32 feet between Sturgeon and Stony lake. Thence free access to Clear lake is possible. Lakefield, at the southerly extremity of Clear lake, the end of the navigable waters of this section, is 66 miles from Balsam lake. The several very excellent locks and dams on this important section were all built prior to 1890.

The Otonabee river connects Clear lake with Rice lake, passing through Peterboro, the chief town of the Trent canal district and the headquarters of canal construction and operation. The fall of the Otonabee river in its course of ten miles is 155 feet. On account of the numerous rapids and the important riparian rights along its course, the canal location was made, for the most part, beyond the banks of the river.

It is divided into two sections, on each of which construction is far advanced. Earth and rock excavation, locks, dams, bridges, entrance piers, etc., are well under way, and the work will be practically completed during the present year. Rice lake, twenty miles long and two miles wide, is entered from the Otonabee river by a lock, while another, at its outlet at Hastings, gives access to the final stretch of water of this system,—the Trent river,—from which the canal derives its name.

This "reach" is navigable to Heeley's falls, a distance of fifty-four miles from Peterboro. The succeeding twenty miles of the Trent river, passing through the town of Campbellford, has a descent of 243 feet in its winding course. The canal location leaves the river at Heeley's falls, and, running in a south-easterly direction for eight miles, intersects Hoard's creek at a point four miles above its outlet into the Trent river, at Chisholm's rapids. No work as yet has been done on this section. At Chisholm's rapids there is a dam, a canal half a mile long through continuous rock, and a splendid lock, all

constructed sixty years ago. The river is navigable from the latter point to the town of Frankford, five miles below, where a dam likewise has been constructed. From thence to Trenton on the Bay of Quinte, a distance of seven miles, the river rushes down in a serpentine course, enclosed between high banks with many beautiful cascades. The descent from Frankford to the lake level in the Bay of Quinte is 118 feet.

The writer was engaged in making surveys and plans of fourteen miles of the section between Trenton and Chisholm's rapids during the past year. This section is now about ready for contract, and the district is anxiously awaiting the action of the government in reference to the continuance of the work.

The total distance from Georgian bay to Trenton along the Trent canal route is 204½ miles, of which 146 miles are navigable. Of the unnavigable portion the three sections under contract are about 16 miles long, leaving a balance of 43 miles to be rendered navigable by canals, locks, and dams. From Trenton there are two outlets to Lake Ontario,—one by the Murray canal, 10 miles to the west, the other down the charming Bay of Quinte, 80 miles to Kingston, at the head of the St. Lawrence river. From Kingston to Montreal the distance is 168 miles, making a total from Georgian bay to Montreal of 452 miles.

The cost of the Trent canal has been variously estimated at from two and a half million to ten million dollars. A mean between these two extremes, in the absence of definite data, in all probability, is somewhere near the mark.

A channel 50 feet wide and of sufficient depth to afford a 6-feet draught of water over the miter sills of the locks is being made on this canal. The new locks are being built entirely of concrete, in the proportions of 3½ cubic feet of Portland cement, ¼ cubic yard of sand, ½ cubic yard of screened gravel, and 1 cubic yard of broken stone of two-inch cubes as a maximum. The locks are 142 feet in length between the quoins, and the inside width at the floor level is 33 feet. There is no doubt that a 6-feet draught is entirely too small to render the canal serviceable for more than the requirements of the ordinary local traffic.

As Canada has been enlarging canals for a quarter of a century from a 9-feet to a 14-feet draught, it is to be hoped that the new administration, if it decides to prosecute the Trent canal to completion, will see the necessity of departing from the original 6-feet draught system of the Rideau and Trent canals, and of adopting one at least equal in capacity to the outlet—that is, to the St. Lawrence river canals.

The Trent canal route is 247 miles shorter than the Welland canal route from Lake Huron to Montreal, and 400 miles shorter than the Erie canal route from Lake Huron to New York. It is claimed that the present rate of eight to ten cents a bushel for marketing grain from the interior of Ontario could be reduced about one half. It is also claimed that the present seven-cent rate from Fort William to Montreal, for wheat, *via* the Welland canal, could be reduced very apppreciably by the Trent canal, owing to the shorter distance and the greater security of the inland waters, rendering insurance and other expenses considerably lower. Chicago and Duluth, too, would be enabled to utilize the Trent canal to excellent advantage for their foreign exports, were the latter made of adequate size to accommodate the propellers and barges of the upper lakes. The opening of this alternative Trent canal route would certainly lower freight rates generally, both by water and rail, from the granaries of the great northwest, and thus materially benefit the western agriculturalists, either directly or indirectly, by enabling them to obtain better prices for their products in the markets of the world than have obtained in the past.

Since adequate transportation facilities from the Great Lakes to the seaboard are of paramount importance to the prosperity of millions of people contiguous to the vast inland basin of the North American continent, where nature has nearly completed a navigable route, surely the adjacent progressive countries, with interests almost identical, could make the Trent canal route, the Erie canal route, or, best of all, the Welland and St. Lawrence canal route, a highway adequate to the future traffic demands of both countries.

A spirit of friendship and the application of ordinary business principles would certainly lead to the adoption of an international waterway project, upon which millions of dollars might be expended with the proud satisfaction of knowing that not a dollar was being wasted. The time has come in the history of the United States and of Canada when some definite system, commensurate with the present and prospective demands of the carrying trade, should be constructed. The first step,—the appointment of a commission,— has already been taken. Many citizens of both countries are awaiting the result, hopeful of definite action upon the reports with the least possible delay.

THE VEXED QUESTION OF GARBAGE DISPOSAL.

By Rudolph Hering.

WHEN I acceded to a request to contribute to THE ENGINEERING MAGAZINE an article on the above subject, I expected the early appearance of some reports which are being prepared on an extensive series of experiments made in Europe. These reports have been delayed for many months, and even now the time of their issue is uncertain. This article must, therefore, be confined to a discussion of the present status of the subject, leaving a description of the late European experiments for another article.

Several years ago the American Public Health Association appointed a committee to clear up the subject of the disposal of garbage and refuse, inasmuch as there were great differences of opinion regarding the best methods of disposal. The final report of this committee has not yet been issued. It is being delayed for the purpose of embodying the above-mentioned reports.

The work of this committee has been to obtain information regarding the present methods of collecting and disposing of garbage. Circulars were sent to nearly two hundred cities, and replies were received from about one hundred and fifty. The replies, in most cases, have naturally been incomplete. In order to answer some of the questions, it would have been necessary to make special investigations, which could not be expected. The information which the committee obtained, nevertheless, constitutes a very complete record of the present status of the question in this country, including also the opinions of various health officers and others who have sent replies. From year to year the results have been reported to the Association. The present article contains the sum of these reported results, and, also, a reference to those gained in Europe.

If the disposal of garbage and refuse is to be considered satisfactory in any city, it must be so from an economical, as well as from a sanitary, standpoint. Regarding the sanitary question, it should be said that no evidence reached the committee indicating a serious effect upon the health of those engaged in the work, either in the collection of the refuse, in picking it over, or in finally disposing of it. The writer, in examining a refuse station in the heart of London, saw a large number of women and children engaged in picking over the refuse, and was told that no unusual sickness among the employees had ever been re-

ported. In fact, there was a great desire to obtain an appointment at the works, and many applicants were on hand when a vacancy occurred.

Nevertheless, it is true that such works, unless very carefully managed, may become a nuisance to the neighborhood. It also seems at least probable that filth and street-sweepings in which disease-germs are harbored may sometimes reach the garbage and refuse depository, and thereby communicate disease. A satisfactory disposal of this material must therefore embody the destruction of infectious matter.

The economical question is of much practical importance. Unless a satisfactory disposition of garbage can be accomplished at a reasonable expense, it is not likely that all cities will at once adopt it. There are, in fact, many cases where the method of disposal is not determined by the city. It often awards a contract to the lowest bidder, and, in doing so, adopts the system recommended by him.

In order to appreciate the import of the experience gained in different cities, it was necessary at first to ascertain the true meaning of the designations given to this refuse in different parts of the country. The committee defined the term garbage as follows:

"By the term garbage is meant animal and vegetable waste-matter subject to rapid decay, from kitchens, markets, slaughter-houses, etc., but not including night soil and street-sweepings. By the term dry refuse is meant the miscellaneous material comprising the dry waste-matter from houses, stores, factories, and streets, such as ashes, paper, straw, wood, rubbish, etc."

In some of the southern States the term garbage is sometimes applied to dry refuse, and also to a mixture of dry refuse with animal and vegetable waste. The word "swill" is used commonly in New England to distinguish kitchen waste, while in Pennsylvania the word "slop" is applied to this material.

A discussion of the disposal of garbage is made difficult in our country by the lack of an analysis of the material. There are but few cities where a record could be obtained regarding its composition. It differs sometimes materially, not only in different cities, but in a single city. In the business part, for instance, the character will differ from that in the residence districts, and in each case it varies with the size of the city and with the season.

Where the kitchen refuse alone is considered, the moisture, or water contained in it, is much greater than where this refuse is mixed with ashes or general rubbish. On the average, we may say that garbage without dry refuse contains from sixty to eighty per cent. of water. We may further say that the animal and vegetable matter form about twenty per cent. of the combined garbage and dry refuse of a town. The quantity of grease contained in garbage has been found to vary

from two to four per cent. Where garbage is cremated, the ashes constitute about five per cent. of the original mass.

Until more information is at hand regarding the composition of garbage and dry refuse, it will be difficult in a general way to determine the most economical and sanitary method of disposal. The various methods now in use in one hundred and fifty American cities are:

Filling in or plowing into land, in 46 cities;

Dumping at sea or into a large river or lake, in 14 cities;

Feeding to animals, in 43 cities;

Reduction to grease and fertilizer, in 17 cities;

Cremation, in 30 cities.

Some cities use two methods of disposal, but credit is here given only to the principal or the more satisfactory one.

Filling into or dumping upon waste land is naturally inexpensive, and is, therefore, a more common method of disposal than it should be. Plowing into land, with the expectation that the manurial value of garbage will be utilized, is more expensive, and only one city has adopted this method exclusively. There is no assurance, in most cases, that at some future time, when the ground is used for building purposes, this organic refuse, in its partially-decayed condition, will not cause serious trouble. Such a method, therefore, is dangerous and improper.

Dumping at sea or into a large river is not objectionable when the material is effectually removed by the current. Some of it serves as food for fishes, and some is deposited. There are instances where this method is entirely unobjectionable. Where the garbage drifts ashore, or tends to fill up the river-bed, of course it cannot be permitted.

Feeding animals with garbage is common in New England, and generally in small towns throughout the country. When the material is fresh,—that is, not more than one day old,—and consists only of rejected or surplus food materials from kitchens, no danger results, and the economical value of the nutriment may be safely realized. But in large cities it is almost impossible to prevent a pollution of the material by dangerous substances, or premature decomposition, before disposal. In Massachusetts and Pennsylvania, evidence has been produced showing that garbage-fed pigs have been less healthy, and more frequently affected with trichinosis, than those which were given better food. Therefore, as a common method of disposal in large cities, this one should not be defended.

Reducing garbage to grease and fertilizer has been practised in this country for a number of years. It has been developed by several companies, operating different processes, the more prominent of which are known as the Merz, Simonin, and Arnold systems. In the first two

naphtha is added to the garbage, which dissolves and extracts the grease contained in it, leaving the remainder in a condition to be used as a filling or diluting material for a better class of fertilizers. In the Arnold process the garbage is boiled sufficiently long to extract the grease and water, which are subsequently removed by heavy pressure, and leave, as in the other systems, a material available as a fertilizer.

From a sanitary point of view, it may be said that the reduction method allows the garbage to be subjected to so high a degree of heat that any matter dangerous to health will be destroyed thereby, if the work is carefully done. In the operation of nearly all such works it is found, however, that the economy does not allow of sufficient care to prevent occasional offensive odors from creating a nuisance in the neighborhood. Complaints have been made in nearly all such cases, and in some cities reduction works have either been abandoned, or removed to a safe distance.

The advantage claimed for reduction works is the destruction of the garbage, and at the same time the securing of a profit from the manufacture of grease and fertilizer. If the prevention of a nuisance is insisted upon by the authorities, the profit is materially diminished, and in some cases has been entirely extinguished.

Owing to the economical necessity of having a large plant, the reduction method has never been extensively operated except in large cities, the principal ones being Providence, New York, Brooklyn, Philadelphia (in part), Buffalo, Cincinnati, Detroit, Milwaukee, St. Louis, and New Orleans. In some of these cities it has given considerable trouble and dissatisfaction, and in two of them the works have been abandoned, because their proper operation was too costly. During late years the prices of garbage grease and fertilizer have fallen materially, and the profits have been correspondingly diminished. The grease was formerly sold at three cents per pound; to-day it brings about one and half cents per pound. The fertilizer has similarly fallen in price. Probably the best reduction plant to-day is that situated on Barren island, where the garbage of New York and Brooklyn is being treated by boiling, the grease being subsequently extracted by pressure. Whether this plant can be profitably operated for the contract term of five years without causing a nuisance remains to be seen.

The cost of the reduction process has varied considerably in the different cities. The returns show a variation of from 10 cents to 67 cents per capita, excluding the cost of the disposal of dry refuse.

The cremation of garbage, or its destruction by fire, is practised more particularly in small cities, although Montreal, Washington, Atlanta, Philadelphia (in part), Allegheny City, and Wilmington, Del., also use it. The method seems to be growing in favor in this

country. In Europe it is, and has been for many years, considered the only one giving satisfaction in both large and small cities, whereever garbage has been subjected to any treatment.

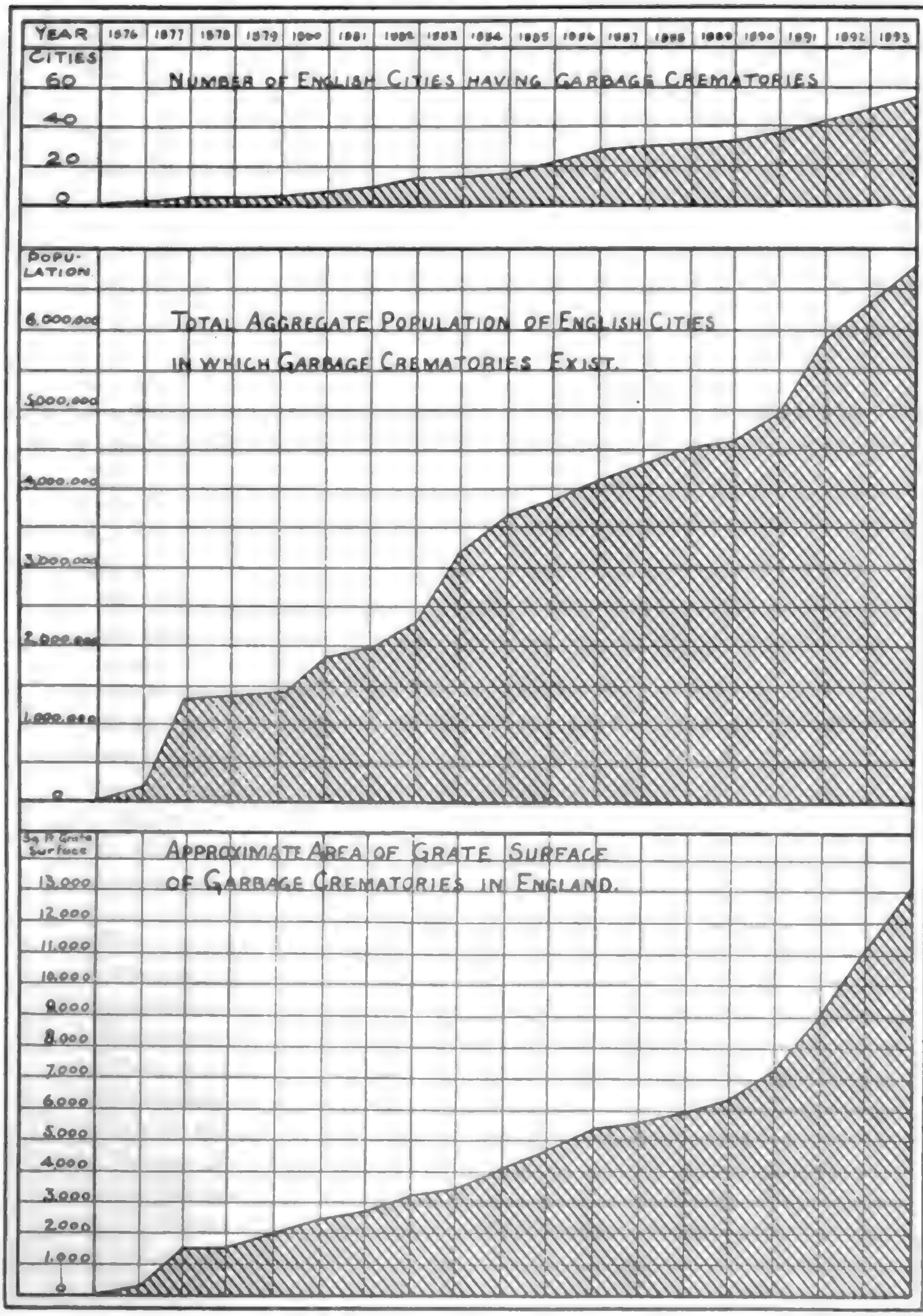
Cremation is accomplished in furnaces, of which there are a number of designs in use. The Engle, Dixon, Brown, and Thackeray furnaces are the principal ones used in America. In Europe the Fryer, Warner, and Horsfall furnaces are the most common. These crematories, furnaces, or destructors (as they are called in England) differ more or less radically in their design. The English destructors generally have a grate surface of about twenty-five square feet. The garbage is fed upon the grate by gravity down an inclined plane, in such a manner that it allows the material gradually to become thoroughly dry before it reaches the grate. The Thackeray furnace, as erected in Montreal, is an imperfect imitation of them. The differences between the English furnaces themselves are found principally in the details of firing, draft, and feeding.

The American furnaces have larger grates. They average from 5 to 6½ feet in width, and from 12 to 20 feet in length. The garbage is dumped directly upon the grate bars from openings at the top, in its fresh state, without previous drying, and is spread out over the bars and raked from below.

In Europe it has been generally found that the garbage and dry refuse (which are mixed and destroyed together) will be consumed without the addition of coal or other fuel. In the American furnaces the addition of such fuel has been found necessary in every case. For this reason, and also on account of the larger experience of the men, who generally hold such positions for life, it is found that the cost of cremation in Europe has been much less than in America. In some cities steam is generated by the fires, and the power thus gained, by being utilized for various purposes, has reduced the cost of destruction. In Montreal, it is stated, the furnace erected after English patterns has not required any coal for the destruction of the refuse.

The fact that the English furnaces are giving much more economical results is probably due also to the fact that the garbage is delivered to the grate with much less moisture and mixed with the dry refuse of the town, which consists largely of unburned coal, wood, paper, straw, and sometimes also street-sweepings, etc., much combustible material being thus added.

A large amount of fine ashes will clog the fires and reduce the draft and combustion, so that in many instances it has been found necessary to first sift out the fine ashes. These are used for filling and for other similar purposes. Whatever organic matter passes the screens and mingles with the fine ashes, although it is found in some cases to



GRAPHICAL TABLE SHOWING PROGRESS OF GARBAGE CREMATION IN ENGLAND.

be as much as fifteen per cént., does not become objectionable, probably on the same principle that earth-closets will take up even a much greater percentage of organic matter without causing a nuisance.

The greatest objection to the burning of garbage is due to odors arising from imperfect combustion. To prevent this it is necessary either to use great skill in attending the fires, which can be attained only by long practice, or to pass the fumes from the furnace through a special fire and thoroughly burn them before they pass up the chimney. The latter expedient is used, when necessary, in most of the English furnaces, and adds slightly to the cost. Some of the American furnaces have a like provision. Another objection to garbage cremation is the escape from the chimney of fine dust which settles upon the neighboring ground. To prevent this a part of the main flue is usually widened into a good-sized chamber, so that the current is slackened, and the dust deposited and subsequently removed.

The annual cost of garbage-disposal by cremation in the United States is found to vary from three to six cents per capita in large cities, and from six to ten cents per capita in medium-sized cities; in one small city the figure reaches twenty cents. The cost of refuse-destruction by fire in Europe is very slight in most cases, and in some there is even a profit obtained by the production and utilization of steam.

To show the growth of garbage-cremation in England, which is almost the exclusive method used in that country, I append a graphical table which explains itself and will be of interest in showing the evident satisfaction with the results.

The present article may be closed with the conclusions reached in a late report made by certain city officials of Zurich, Switzerland, after having visited the best works of Europe, and made experiments with the material collected in their own city. They say:

"Destruction of refuse by fire is to be recommended. This method will not entail a greater expense than the more crude methods used heretofore. With the latest improvements and with careful management, no objectionable results will follow in the immediate or more distant surroundings of the garbage furnaces. From a sanitary point of view, cremation is the only correct method of disposal, particularly during epidemics. This method secures invaluable service by including, with the material to be cremated, dust and the sweepings from buildings and public streets. During ordinary times this process is also beneficent, because it does away with the accumulation of the more or less objectionable matter which otherwise must be dumped in the neighborhood of habitations. The slight and sometimes questionable value of the refuse for fertilizing purposes should not be placed against the much greater value of better sanitation."

EPOCH-MAKING EVENTS IN ELECTRICITY.

By G. H. Stockbridge.

III.—ARAGO—THE BEGINNINGS OF MAGNETO-ELECTRICITY.

FOR a long series of years, beginning with the date of its foundation in 1816, the French journal, *Annales de Chimie et de Physique,* had for its editors Joseph Louis Gay-Lussac and François Jean Dominique Arago, two of the most eminent physicists in the world. This journal was accustomed to publish, besides many extended scientific papers, abstracts of the proceedings of the French Royal Academy of Sciences, of which both editors were members. In its report of the Academy's meeting of November 22, 1824, the following notice appeared: "M. Arago verbally communicates the results of some experiments which he has made concerning the influence exercised by the metals and many other substances upon the magnetic needle, which influence results in rapidly diminishing the amplitude of the oscillations without sensibly altering their duration. He promises a detailed memoir on this subject."

The same periodical, in the course of its account of the Academy's meeting of March 7, 1825, makes the following statement: "M. Arago brings to the attention of the Academy apparatus which shows in a new form the action which magnetized bodies, and those that are not magnetized, exercise upon each other.

"In his first experiment (see the number for December, 1824, page 363) M. Arago had proved that a disc of copper, or any other substance, solid or liquid, placed below a magnetic needle, exercises upon this needle an action whose immediate effect is to alter the amplitude of the oscillations, without sensibly changing their duration. The phenomenon with which he has entertained the Academy to-day is, so to speak, the reverse of the former. Inasmuch as a moving needle is arrested by a disc at rest, M. Arago has thought it would follow that a needle at rest would be drawn along by a moving disc. If a copper disc, for example, is rotated with a definite speed under a magnetic needle, enclosed on all sides in a closed vessel, the needle does not place itself in its ordinary position. It comes to rest outside the magnetic meridian, and, indeed, the farther from this plane, the more rapid the rotary movement of the disc is. If this rotary movement is sufficiently rapid, the needle, at any distance from the disc, turns, itself, continuously about the filament from which it is sus-

pended. We shall in the near future report upon the laws of these singular phenomena."

These two brief notices travelled in the usual course to Germany, where they at once engaged the attention of Seebeck and Pohl; to Switzerland, where Prevost took up the investigation; to Italy, where Nobili and Bacelli made experiments upon the subject; and to England, where Herschel, Babbage, Christie, and Harris brought the matter before the Royal Society, with much experimental detail, and much discussion of the theory. Additional interest was given to the study of the subject in England—if, indeed, the study was not thus initiated—by a visit which Gay-Lussac made to London in the spring of 1825, during which the celebrated French physicist delighted his British *confrères* by enlarging upon this latest bit of scientific news. Far more entertaining it was to some of them, we may believe, than the reports of the Turkish investment of Missolonghi, which were circulated about the same time. And a Philistine public, which often wonders at the enthusiasms of science no less than at those of art, may, even in these days when the sentimental interest in the Grecian struggle with the Turks is renewed at its old height, be brought without misgivings to face the question whether these scientific enthusiasts of 1825 had not ample justification for their preference. True, Greece had to be freed, and the Turk must eventually—however far in the future—be thrust out of Europe for the protection of Christendom and the good of the race, but other things were no less imperative. If we were ever to have Niagara for our bondman, with all which that promises; if we were to have the electric light and electric power in their present state of development, and with the advances that seem to be at hand; if we were to have that enlargement of our knowledge of nature, whose meaning is only now beginning to unfold,—it needed that these men should have faith in their predominant instinct, and should try first of all to find out what nature meant by letting a non-magnetic disc cause the rotation of a magnetized needle, just as if it were itself a magnet.

At least, that was what the phenomena seemed to indicate. Duhamel, according to Arago, was the first to put the magnetic theory into formal statement, though Arago also declares that the theory was not absent from his own mind at the time when he made the first disclosure of his discovery to the Academy. For some reason Arago withheld the statement of it, and contented himself with the promise, as we have seen, of a theoretical explanation later. His first utterance of that kind was contained in a paper replying to certain of his critics, and discussing the theories put forth by the philosophers who took up the theoretical investigation long before Arago was ready to ful-

fill his promise. Even in this paper, which was read to the Academy July 3, 1826, Arago is more concerned to deny that Barlow's experiments with an iron sphere rotating near a magnetic needle were genuine anticipations of his own experiments, either in point of date or in principle, than to set forth a working theory of what he had done.

I have been unable to find the passages in *Brewster's Journal* which aroused Arago to prepare this vindication, but their character is well enough indicated by Arago himself, and his reply is passionate as well as conclusive. It appears that Sir David Brewster, in some one of the many scientific publications with which his name is identified, had, in April, 1826, claimed for his countrymen the original discovery of the "magnetism of rotation," and had further declared that, "with the exception of a small number of important experiments made in France, it had been exclusively followed up by the members of the Royal Society." By Brewster's account, then, it was Barlow who discovered the "magnetism of rotation," and it was the British school of physicists that had pursued the inquiry than which—still according to Brewster—"few branches of modern science deservedly excite a more lively interest." Brewster overlooked the fact that Arago's work was anterior to Barlow's, as well as the radical differences between the two types of experiment, and he appears to have been totally unaware, in the usual British way, of the investigations of the German, Swiss, and Italian philosophers whose names have been rehearsed above. Yet Herschel and Babbage, whose theoretical studies Brewster must chiefly have had in mind, had set up their apparatus in Babbage's house to repeat and enlarge Arago's experiments, not Barlow's, and their theory of the reactions was based mainly on their study of the French *savant's* work. There was ample justification, it would seem, for Arago's heat in denouncing Brewster for disregarding his well-grounded and well-known prior claims.

Strangely enough, the explanation of the phenomena given by nearly all the philosophers was false as to Arago's discovery and true as to Barlow's. By pure accident the targets were so arranged that whoever missed the first would be sure to hit the second. The accepted statement of the theory is that presented by Herschel and Babbage to the Royal Society. Briefly stated, their conception of the action is that the pole of the magnetic needle causes an opposite pole in the nearest part of the copper disc, and that a diffused polarity of the same kind surrounds the induced pole. The disc, in being rotated, is supposed then to acquire and lose its magnetism, not instantly, but in a sensible period. Accordingly there will always be an

attractive force tending to advance the needle in the direction of the disc's rotation. Now, this agrees perfectly with what happens when a disc or sphere of iron is the rotating body. But neither Arago or Ampère could discover the presence of any induced magnetism in the copper disc, and they were even convinced by special experimentation that the action was one of repulsion. The way matters stood was that the current theory was inconsistent with the observed facts, and yet neither the originator of the experiments or any other physicist was prepared to advance a more consistent explanation.

The solution came in a roundabout way. Michael Faraday, perhaps the most brilliant of the great minds that have chosen electricity as their field of research, made public in November, 1831, the results of his attempts to obtain electricity from magnetism, and, in doing so, he described how, by suddenly creating a magnet in the neighborhood of a helix connected with a galvanometer, or by causing a relative movement between magnets and helices so connected, he could generate electricity, as shown by momentary deflections of the galvanometer needle. Magneto-electric induction being once proved in this manner, it flashed upon the mind of its discoverer that the phenomena of Arago's disc were now explicable under a new hypothesis. Arago's magnetic needle remained a source of induction, but, instead of inducing magnetism in the copper disc, it induced electric currents. To Faraday himself it was a complete surprise. He simply found that the same key which had unlocked the larger chamber opened the door of the room into which Arago had stumbled. It seems fitting to give a somewhat long extract from Faraday's account of the matter.

"The momentary existence of the phenomena of induction now described," he says, "is sufficient to furnish abundant reasons for the uncertainty or failure of experiments hitherto made to obtain electricity from magnets.

"It also appears capable of explaining fully the remarkable phenomena observed by M. Arago between metals and magnets, when either are moving, as well as most of the results obtained by Sir John Herschel, Messrs. Babbage, Harris, and others, in repeating his experiments, accounting at the same time perfectly for what at first appeared inexplicable,—namely, the non-action of the same metals and magnets when at rest."

Assisted by Mr. Christie, Faraday took a magnet made up of about four hundred and fifty bar magnets, "each fifteen inches long, one inch wide, and half an inch thick, arranged in a box so as to present at one of its extremities two external poles. To concentrate the poles and bring them nearer to each other, two iron or steel bars,

each about six or seven inches long, one inch wide, and half an inch thick, were put across the poles," so as to be adjustable to and from each other.

"A disc of copper, twelve inches in diameter, and about one fifth of an inch in thickness, fixed upon a brass axis, was mounted in frames, so as to allow of revolution either vertically or horizontally, its edge being at the same time introduced more or less between the magnetic poles. The edge of the plate was well amalgamated for the purpose of obtaining a good, but movable contact, and a part round the axis was also prepared in a similar manner.

"Conductors or electric collectors of copper and lead were constructed so as to come in contact with the edge of the copper disc, or with other forms of plates hereafter to be described. These conductors were about four inches long, one third of an inch wide, and one fifth of an inch thick; one end of each was slightly grooved, to allow of more exact adaptation to the somewhat convex edge of the plates, and then amalgamated. Copper wires, one sixteenth of an inch in thickness, attached, in the ordinary manner, by convolutions to the other end of these conductors, passed away to the galvanometer.

"The galvanometer was roughly made, yet sufficiently delicate in its indications. The wire was of copper, covered with silk, and made sixteen or eighteen convolutions. Two sewing-needles were magnetized and fixed on to a stem of dried grass parallel to each other, but in opposite directions, and about half an inch apart; this system was suspended by a fibre of unspun silk, so that the lower needle should be between the convolutions of the multiplier, and the upper above them. The whole instrument was protected by a glass jar, and stood, as to position and distance relative to the large magnet, under the same circumstances as before.

"All these arrangements being made, the copper disc was adjusted, the small magnetic poles being about half an inch apart, and the edge of the plate inserted about half their width between them. One of the galvanometer wires was passed twice or thrice loosely round the brass axis of the plate, and the other attached to a conductor, which itself was retained by the hand in contact with the amalgamated edge of the disc at the part immediately between the magnetic poles. Under these circumstances all was quiescent, and the galvanometer exhibited no effect. But the instant the plate moved, the galvanometer was influenced, and, by revolving the plate quickly, the needle could be deflected ninety degrees or more.

"It is difficult, under the circumstances, to make the contact between the conductor and the edge of the revolving disc uniformly good and extensive; it was also difficult in the first experiments to ob-

tain a regular velocity of rotation; both these causes tended to retain the needle in a continual state of vibration; but no difficulty existed in ascertaining to which side it was deflected, or, generally, about what line it vibrated. Afterwards, when the experiments were made more carefully, a permanent deflection of the needle of nearly forty-five degrees could be sustained.

"Here, therefore, was demonstrated the production of a permanent current of electricity by ordinary magnets.

"When a mere wire, connected with the galvanometer so as to form a complete circuit, was passed through between the poles, the galvanometer was affected; and, upon moving the wire to and fro, so as to make the alternate impulses produced correspond with the vibrations of the needle, the latter could be increased to twenty or thirty degrees on each side the magnetic meridian.

"The experiments described combine to prove that, when a piece of metal (and the same may be true of all conducting matter) is passed either before a single pole, or between the opposite poles of a magnet, or near electro-magnetic poles, whether ferruginous or not, electrical currents are produced across the metal transverse to the direction of motion; and which therefore, in Arago's experiments, will approximate towards the direction of radii. If a single wire be moved like the spoke of a wheel near a magnetic pole, a current of electricity is determined through it from one end towards the other. If a wheel be imagined, constructed of a great number of these radii, and this revolved near the pole, in the manner of the copper disc, each radius will have a current produced in it as it passes the pole. If the radii be supposed to be in contact laterally, a copper disc results, in which the directions of the currents will be generally the same, being modified only by the coaction which can take place between the particles, now that they are in metallic contact.

"Now that the existence of these currents is known, Arago's phenomena may be accounted for without considering them as due to the formation in the copper of a pole of the opposite kind to that approximated, surrounded by a diffuse polarity of the same kind; neither is it essential that the plate should acquire and lose its state in a finite time; nor, on the other hand, does it seem necessary that any repulsive force should be admitted as the cause of the rotation.

"But it is possible (though not necessary for the rotation) that *time* may be required for the development of the maximum current in the plate, in which case the resultant of all the forces would be in advance of the magnet when the plate is rotated, or in the rear of the magnet when the latter is rotated; and many of the effects with pure electro-magnetic poles tend to prove this is the case. Then, the tan-

gential force may be resolved into two others, one parallel to the plane of rotation, and the other perpendicular to it: the former would be the force exerted in making the plate revolve with the magnet, or the magnet with the plate; the latter would be a repulsive force, and is probably that the effects of which M. Arago has also discovered.

"The extraordinary circumstance accompanying this action which has seemed so inexplicable—namely, the cessation of all phenomena when the magnet and metal are brought to rest—now receives a full explanation; for then the electrical currents which cause the motion cease altogether."

The puzzling discovery which Arago made in 1824 or 1825, as we have seen, may be said to mark, rather than to make, an epoch. It recalls a period when scientific men the world over were seeking to generate electricity by the use of magnetism as a source. The experiments of Arago excited the deepest interest, but the disc remained a marvel rather than the origin of a great line of arts. The wonderful thing was in their hands, but they did not know what it was. If I may recur to the figure employed in the first of this series of articles, I may say that Volta, with his crown of cups, discovered the main land upon which all the later progress in galvanism or voltaism has been made; Oersted, with his moving needle responsive to the electrical currents, touched upon a peninsula which was afterwards shown to be connected with the main land by firm earth; while Arago hit upon an island, having the same constituent elements in its soil as the near-by land, but not connected with it. The arts of magneto-electric induction have a wide water-gap between them and Arago's island. So long as we waited for that to be the starting-point,—or at least until we had bridged the gap by discovering the true theory of the Arago phenomena,—there would have been no hope of advancing to the developments which we now know. In truth, the art remained for six years where it began, and then blossomed quickly into full expansion on Faraday's discovery of the true theory. There is, perhaps, no better illustration in all the arts of the importance of a right interpretation of nature, if we are to make her useful to mankind, than this barren experiment of Arago's, when compared with the fruitfulness of the subject as proved by the later intelligent development under a correct explanation of the things observed.

ENGINEERING PROBLEMS OF THE TALL BUILDING.

By Charles O. Brown.

FROM the earliest historic time men have built shelters in which to find protection from the elements. These consisted of walls and a covering over them. Doors were formed by two stones set on end, with a flat stone across the top. On general principles, there has been little change in four thousand years. We are doing the same thing to-day. But the value of lots has increased, and architecture, being prevented from extending sidewise, has been forced skyward. When buildings reached eight and nine stories, the question was asked: How will they stand up in a gale blowing one hundred miles an hour? Here we had reached the point where it would not answer any longer to simply pile up building stones; it had become necessary to use material of greater strength to stiffen the structure.

This step once taken, it was obvious that the conventional thickness of walls could be reduced, thereby adding to the net cubical contents, or renting-space, of the building, and the architect found it very convenient to be able to make his design almost regardless of the structural features, as the skeleton frame could be designed to suit his plans.

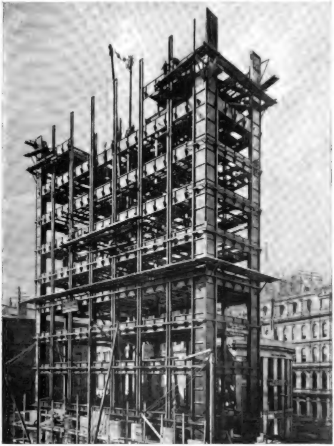
Engineering principles are few and simple. Archimedes said two thousand years ago: "Give me a lever and fulcrum, and I will lift the world off its hinges." So the engineer of to-day will solve any problem, if he is given the modern lever,—namely, money. The engineering problem involved in the construction of the modern sky-scraper does not present many new features.

A good bridge engineer requires but little additional knowledge to enable him to master the engineering work for buildings, and the New York *Sun*, when describing the new Manhattan Life Building about two years ago, very aptly headed the article "A Bridge on End."

The data required by the engineer and furnished by the architect are: a survey of the lot and a general layout of the proposed building, together with a description of the material to be employed for walls, floors, roofs, partitions; also a report of the borings, showing the nature of the ground at different depths.

His work consists in the following: verification of the survey by comparing it with the actual dimension of the lot; computation of the dead load of the structure; determination of the live load for which the

building is to be designed, usually fixed by law; locating the columns, floor girders, and beams; computation of the strains produced upon each member of the skeleton by live and dead load; computation of the strains produced by a wind pressure of thirty pounds per square foot; the proportioning of all the members of the skeleton, so that the strains may not exceed the limits fixed by law; a careful estimate of the dead weight, to see that the assumed load is correct; the designing



THE SKELETON OF A SKY-SCRAPER. THE WORTHINGTON BUILDING, BOSTON, MASS.

THE MANHATTAN LIFE BUILDING, PARTLY COMPLETED.
Showing structural framing of the bracing across the light court and of the upper stories of main building and lower part of the tower.

of the foundation, which is usually carried to rock by means of pneumatic caissons. In doing this work the designer cannot give his ingenuity much latitude; he must keep within the somewhat narrow limits of the law. The building law of the city of New York has been considered a model, and undoubtedly buildings constructed under the same are safe; but, when applied to tall buildings, its provisions are too exacting, and involve unnecessary expenditure.

The live load of one hundred pounds for office-buildings, as fixed by law, is too high, and the requirement that each of twenty floors shall be figured for that load compels the engineer to proportion the lower columns for strains which in reality never exist.

The required thickness of curtain walls is also excessive. For a building three hundred feet high, they must be thirty-two inches in the lower stories. If the skeleton is capable of sustaining all the strains that may come upon it, and is properly protected against rust and fire, it should be left to the architect to say how thick a wall will form the required shelter and furnish a sufficient non-conductor to avoid rapid changes of temperature in the building.

Realizing this fact, the superintendent of buildings called a convention consisting of representatives of all the building trades and of societies interested otherwise in buildings and real estate, which met in the winter of 1895-96. The work of revision was done by committees selected by the convention, and was nearly completed when the Greater New York commission decided to embody the old law, slightly modified, in the new charter, leaving the necessary revision for the municipal assembly. An extract from the report of the committee on formulas and calculations, as approved by the digest committee, which relates to the strength of materials, is appended to this article.

A few of the features recently adopted in building construction, and now universally used, are the following.

The Pneumatic Caisson, which, as used in the foundations for the Manhattan Life, the Standard Oil, and Empire Buildings, enables the engineer to go to rock without disturbing the adjoining buildings. This system has been used extensively for bridge work. The Brooklyn bridge piers are founded in the same manner.

Steel Columns, which have taken the place of cast-iron columns,—at least in cases where the columns may be subjected to bending strains.

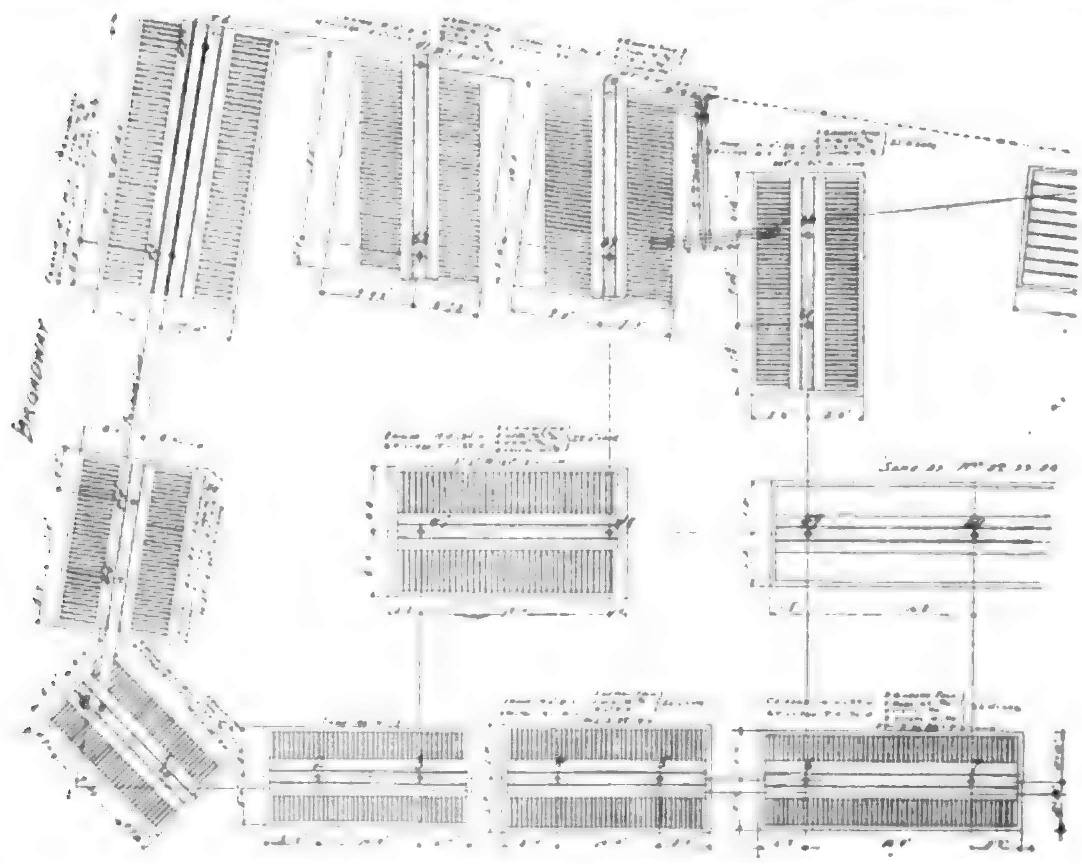
Knee Bracing. To resist the wind pressure in bridge towers, diagonal bracing is used, but this, if applied to buildings, would interfere with door- and window-openings; hence knees are substituted. These knees produce bending strains on the girders and columns to which they are attached.

ADDING TO THE HEIGHT OF AN EXISTING BUILDING. LOWER BROADWAY, NEW YORK.

The Cantilever, used mainly in foundations. Columns on or near the party lines would exert an undue pressure along the edge of the foundations; to avoid this, they are placed on the overhanging arm of a girder, supported over the center of a circle, square, or rectangle of sufficient size to reduce the unit pressure to a safe limit, and located so as not to go beyond the lot line.

The Grillage. The old base for columns used to be a cast-iron plate about three inches thick, laid on granite. As loads on columns increased, it developed into large bed-castings up to ten feet in diameter and four feet in depth, provided with ribs and flanges. This is the mechanical limit in cast iron. Where the loads had to be distributed over still larger areas, the strength was obtained by two or more layers of steel beams or riveted girders, constituting a steel grillage, which, calculated on scientific principles, made it possible to dispense with the expensive granite cap-stones, and even with brick masonry, if desired, as the grillage can be placed directly upon a bed of concrete. Wooden grillage has been used for bridge-work for many years, but it was always designed by rule of thumb.

The question of greatest importance in connection with these costly buildings is the protection of the metal skeleton against corrosion and fire. Corrosion results from the combined influence of moisture and



PART OF THE CAISSON FOUNDATION AND GRILLAGE PLAN OF EMPIRE BUILDING, N. Y.

RAISING THE STANDARD BLOCK.
Showing the equalizing girders over the ninth story of the old building, and lower part of the skeleton framing for the new portion.

air upon the metal. If either of these is excluded absolutely, corrosion will not take place, provided no acids or other deleterious matters can come in contact with the metal.

Paints and coatings of all sorts are proposed. In the opinion of the writer, the best method is to thoroughly envelop all parts of the frame in Portland-cement masonry. For this reason the columns and girders should be constructed so that no hollow spaces remain, such as the interior of box-columns and girders. In bridge-work, where the metal cannot very well be surrounded by masonry, it has been the rule for twenty-five years to exclude all box sections, so that all parts may be at any time inspected and painted. Where cast iron may be used, the danger from rust is smaller, the interior of these columns being almost entirely free from its action.

Burned brick is accepted as the best protection against fire. Eight inches of it on the exterior faces of columns, four inches on the interior,

THE STANDARD BLOCK, NEARLY COMPLETE.

and two inches for the lower flanges of beams, are considered to be a sufficient protection.

On lower Manhattan non-fire-proof buildings are constantly being torn down and replaced by modern fire-proof buildings, and with each operation of this kind the danger from a general conflagration is diminished. Not all the modern buildings are erected with the greatest possible security against fire, but improvements in that direction are progressing steadily. Our fire-extinguishing apparatus is ineffective at a height of more than one hundred and twenty-five feet, and it would be well to restrict the use of inflammable material in buildings exceeding that height. Concrete floors are now extensively used, and the use of aluminum or other metal for windows, doors, wainscot, and trim would still further diminish the danger from fire.

The opinions on the fire-resisting qualities of various materials differ widely. Tests are generally made by interested parties desiring to show good results for their goods. It is hoped that the building commissioners of Greater New York will be empowered, and provided with means, to establish a bureau of tests, so that the true character of these materials may be ascertained by disinterested parties. The labors of such a bureau, if extended to the investigation of the

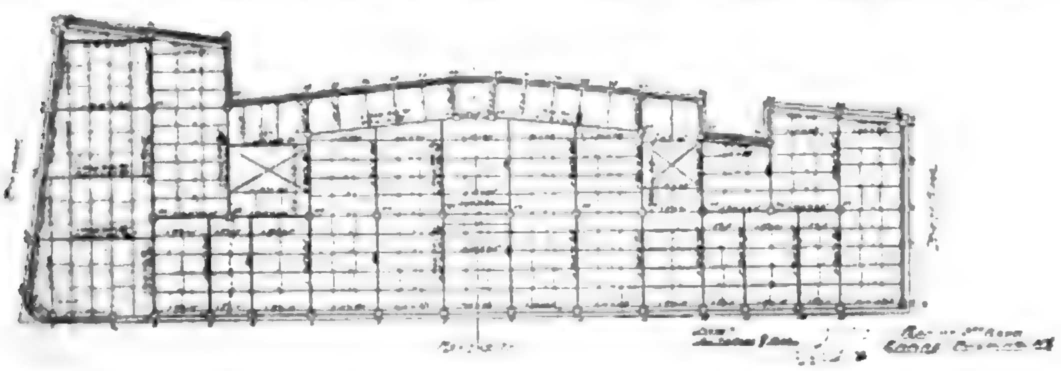
strength of other materials, would be of incalculable value to building interests.

A law limiting the heights of buildings should harmonize with sanitary necessity and artistic taste. From an engineering point of view the limit is fixed by the bearing capacity of the soil, or of the concrete medium when resting on rock.

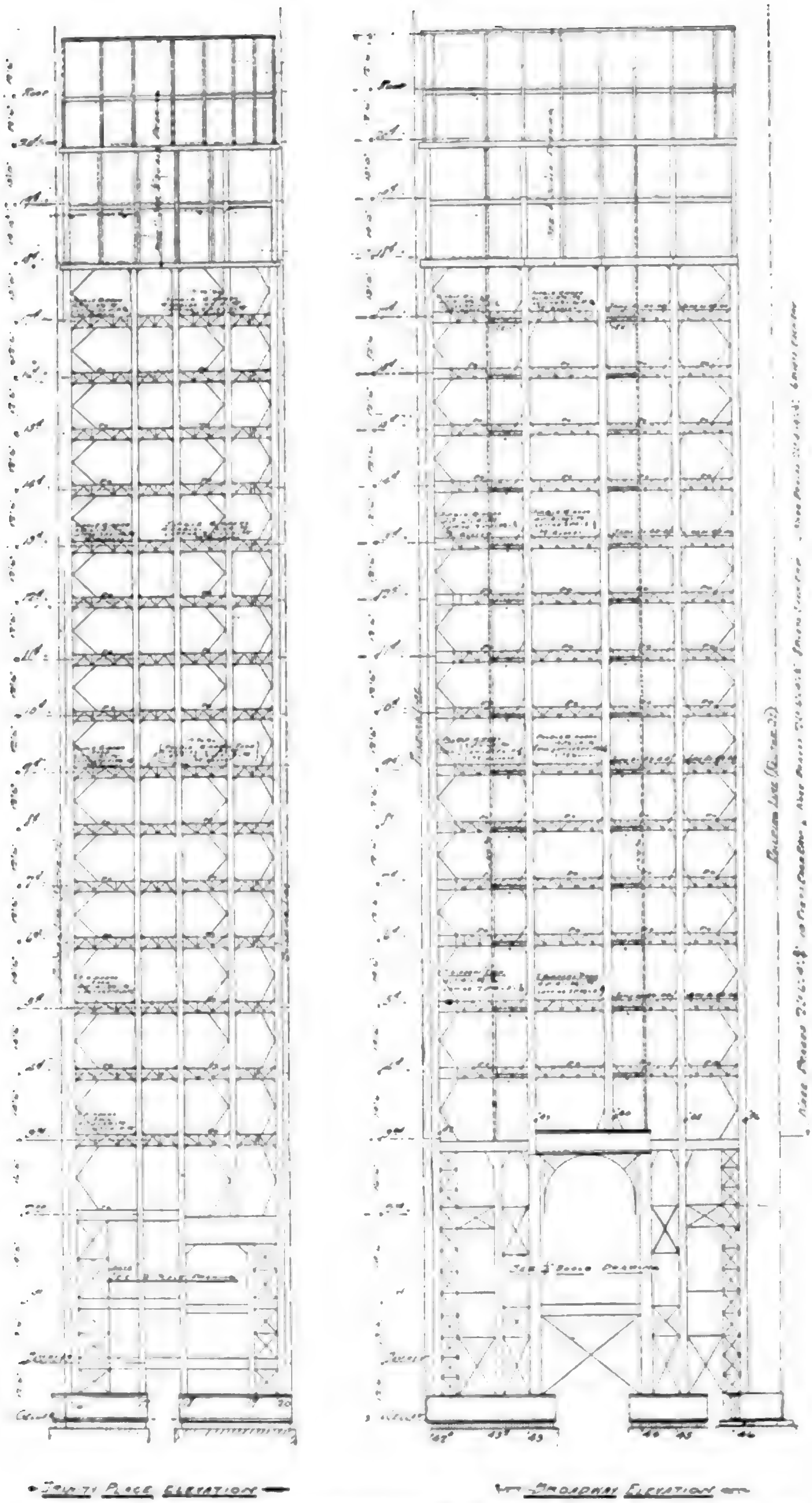
The Empire building, here illustrated, is to have twenty-one stories. It will have a concrete foundation resting on rock. This foundation covers about one-half the area of the lot. The weight on the foundation is not in direct proportion to the number of floors, but increases more rapidly with increased height, so that this building could not be made forty stories high on the same foundation.

From a commercial point of view the competition of these new tall buildings has been severe on the older and lower buildings, and has created a desire to add stories to the latter. This is usually impracticable, especially where the present structure is not of sufficient strength to carry additional weight. There are a few buildings, erected only a short time ago and designed with an excess of strength, which have been raised to obtain the additional renting-space. An illustration is the office-building of the Standard Oil Company, 24–26 Broadway. The problem was to add six new stories to a nine-story building. The solution of the problem was effected by an entirely new addition on the northerly side, having a frontage of twenty-six feet on Broadway and extending through to New street. The building was thoroughly examined in all its details. The actual diameters and thickness of shells of the cast-iron columns were measured; also the dimensions of all brick and granite piers. The plans of the pile foundation were at hand, and evidence was obtained that these plans were duly carried out.

Careful computation of live and dead loads for each supporting column, pier, and wall were made, and, upon comparing these loads with the actual strengths of the supports, it was found that they were generally sufficient to sustain the additional weight, especially if the



A TYPICAL FLOOR-PLAN. THIRD FLOOR OF THE EMPIRE BUILDING.



SKELETON FRAMING AND WIND BRACING OF A TWENTY-ONE STORY BUILDING; THE EMPIRE BUILDING, N. Y.

new loads were carefully distributed, and any local concentrations prevented. A system of lattice girders was designed, forming an immense cap for the old building, and at the same time a base for the new part. These lattice girders extended over the northerly wall, where they were supported by columns running down to new foundations in the extension. New lines of columns were also provided at the few points in the old building which were found deficient. These were made to extend from this system of equalizing girders down to the old foundation. In this manner it was possible for the company to increase the floor-space sixty-six per cent. with moderate cost. The accompanying illustration shows the system of equalizing girders.

The following extract is from the report of the Sub-Committee No. 14 on Formulas and Calculations, as approved by the Digest Committee. These provisions, if embodied in the building laws, would be a long step toward more scientific construction:

The dead loads in all buildings shall consist of the actual weight of walls, columns, floors, roofs, partitions, and all permanent construction.

The live or variable loads are to consist of all loads other than dead loads, and shall be assumed as follows:

Floors for dwellings, offices, and schools, 60 pounds per square foot.

Sleeping rooms, 40 pounds per square foot.

Floors for stables and carriage-houses, 65 pounds per square foot.

Floors for public assembly, 90 pounds per square foot.

Office-floors must be of sufficient strength to safely carry a concentrated load of 4,000 pounds at any point.

Floors for ordinary stores, light manufacturing, and light storage to be computed for not less than 120 pounds per square foot.

For warehouses and factories, not less than 150 pounds per square foot.

Floors constructed for the above loads shall not be used for heavier purposes, except upon permit obtained from the department of buildings.

For sidewalks, 300 pounds per square foot.

Floors for stores, warehouses, and factories must be of sufficient strength to safely carry a concentrated load of 4,000 pounds.

Any floors, or any portion of floors, in any building intended for heavier floor or concentrated loads shall be constructed to support the loads for which they are intended.

The live load on roofs with a pitch of more than 20 degrees shall be assumed at 30 pounds per square foot, measured on a horizontal plane. If the pitch is less than 20 degrees, the live loads shall be assumed at 50 pounds per square foot.

For columns, piers, walls, and other vertical supports in office-buildings, schools, dwelling-houses, and public assembly buildings, a reduction of the live load may be computed as follows: For roofs and top floors the full live load shall be used in the computation of the loads. For the next lower floor, 95 per cent. of the live load may be used. For the next lower floor 90 per cent. For every succeeding lower floor an additional 5 per cent. may be deducted, until 10 per cent. remains, when all succeeding lower floors may be computed for 10 per cent. of the live load established in this act. In computing footings for stores, warehouses, factories, and all buildings in which live loads may be considered as imposed for greater part of the time, 75 per cent. of the full live load only need be transferred to the footings.

For other buildings subjected mainly to the load of people, such as dwellings, office-buildings, hotels, and public assembly buildings, 20 per cent. only of the full live loads may be so transferred to the footings.

The strength of factory floors intended to carry running machinery must be increased above the minimum given in this section in proportion to the degree of vibratory impulse liable to be transmitted to the floor, subject to the approval of the superintendent of buildings.

In columns of compression members of cast iron, steel, wrought iron, or wood, the stress per square inch shall not exceed that given in the following tables:

When the length divided by least radius of gyration equals	Working stresses per square inch of section.		
	Cast Iron.	Steel.	Wrought Iron.
120		6,290	5,814
110		6,860	6,230
100		7,460	6,666
90		8,120	7,117
80	5,710	8,810	7,576
70	6.720	9,540	8,032
60	7,950	10,260	8,475
50	9,400	10,970	8,888
40	11,030	11,620	9,250
30	12,770	12,190	9,570
20	14,380	12.620	9,800
10	15,560	12,900	9,950

And in like direct proportion for intermediate ratios.

When the length divided by the least diameter equals	Working stresses per square inch of section.		
	Long Leaf Yellow Pine.	White Pine, Norway Pine, Spruce.	Oak.
30	437	306	393
25	528	370	475
20	636	445	572
15	757	530	681
10	875	613	787
5	965	676	868

And in like direct proportion for intermediate ratios.

Columns and compression members shall not be used having an unsupported length of greater ratios than given in the tables.

No cast-iron column shall have a less diameter than 6 inches or less thickness than ¾ of an inch, and no part of a steel or wrought-iron column shall be less than ⅜ of an inch thick.

When a column is eccentrically loaded, and the difference between the moments—that is to say, "the load multiplied by its distance from the center of gravity of the section" on any two opposite sides—exceeds 25 per cent. of the smaller moment, then the sectional area of the column shall be increased so that a resisting moment is added which, if computed with the working stress for bending given in section of this act, shall be equal to or greater than the total difference between the moments.

The eccentric load of a column shall be considered to be distributed equally over the entire area of that column at the next point below, at which the column is securely braced laterally in the direction of the eccentricity.

All structures must be designed to resist a horizontal wind-pressure of 30 pounds for every square foot of surface from the ground to the top of same, including the roof,

in any direction. If the moments of wind-pressure exceed 75 per cent. of the moment of stability of the structure, the excess of such pressure must be resisted by bracing, and, in computing the dimensions of this bracing to resist such pressures, all the working stresses specified in section of this act may be doubled. If any building is not over 75 feet in height, the wind strains may be ignored.

In material subject to direct compression or tension the stresses per square inch shall in no case exceed those given in section of this act.

The shearing force per square inch shall in no case exceed the working stress given in section of this act.

In calculating the shearing stresses in metal of rolled sections, the web shall be considered to be the full depth of the metal, and the web alone is to be considered to resist the shearing forces.

In built sections the actual or net area of the web-plate shall alone be considered, and all holes for rivets and otherwise adding ⅛ of an inch to the diameter of the rivets or holes shall be deducted from the area of the section.

In all material under transverse loading the resisting moments computed with the working stresses given in section of this act shall be equal to or greater than the bending moments.

The deflection of beams or girders shall not exceed 3-100 of an inch to the foot of span under the total load.

In masonry arches the line of pressure shall be determined, and the stress at the intrados and extrados at no point shall exceed the working stress for the material as given in section of this act. Nor shall the dimensions at any joint be such as to permit the center of pressure to move more than ¼ of the width of the joint from its center.

Abutments must be proportioned so as to have not less than twice the moment of stability that is required to resist the thrust of the arch. Tie-rods shall be used where necessary to secure stability.

Retaining walls must be proportioned so as to have not less than twice the amount of stability that is required to resist the moment of overturning due to the pressure of the material behind the wall, together with its super-imposed load.

Strength of Materials.—In calculating the resistance of materials under strain (except in the case of columns) the following working stresses per square inch of sectional area shall be employed,—*viz.*,

NO. 1.—WORKING STRESSES IN POUNDS PER SQUARE INCH OF AREA OF CROSS-SECTION FOR DIRECT COMPRESSION.

Metals.		Timber.	With Grain.	Across Grain.
Steel	13,000	Oak	900	500
Wrought Iron	10,000	Yellow pine	1000	400
Cast Iron	15,000	White pine and Spruce	700	200

CONCRETE.

Portland cement, 1 ; sand, 2 ; stone, 4	250
" " 1 ; " 3 ; " 5	200
Rosendale cement, 1 ; " 2 ; " 5	140

BRICK-WORK.

Mortar—Portland cement, 1 ; sand, 3	250
Rosendale " 1 ; " 2	200
Lime, 1 ; sand, 2 or 3	125

NO. 2.—WORKING STRESSES PER SQUARE INCH FOR DIRECT TENSION. ROLLED SECTIONS, RIVETED WORK AND EYE BARS.

Steel	15,000	Yellow Pine	1,250
Iron	12,000	White Pine and Spruce	750
Cast Iron	3,000	Oak	1,000

NO. 3.—WORKING STRESSES PER SQUARE INCH FOR SHEAR.

	Iron.	Steel.
Web-plates	9,000	7,000
Shop rivets and pins	9,000	7,000
Field rivets and bolts	7,000	6,000
	With fiber.	Across fiber.
Yellow pine	150	500
White pine	100	300
Spruce & North Carolina pine	100	300
Oak	200	600

NO. 4.—WORKING STRESSES PER SQUARE INCH FOR BENDING.

Steel	16,000	Greenwich stone	50
Iron	12,000	Indiana limestone	135
Cast iron	3,000	Common limestone	75
Yellow pine	1,200	Sandstone	30
White pine and Spruce	800	North River bluestone	200
Oak	1,000	Concrete, Portland	40
Granite	150	" Rosendale	20

NO. 5.—MODULUS OF ELASTICITY, PER SQUARE INCH.

Steel	29,000,000	Yellow pine	1,500,000
Wrought iron	28,000,000	White pine and Oak	1,000,000
Cast iron	12,000,000	Spruce	1,200,000

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

IV.

IN the preceding article, the extremely injurious effects produced in the boiler by oil scale were fully exhibited, and reference was made to the two general methods of treatment—skimming and filtration. We may now conclude by examining various devices actually employed in these processes, beginning with the simpler forms which merely adapt apparatus already installed so as to make it perform this additional function. Thus some hot wells are constructed so as to form large skimming tanks, and a considerable percentage of the oil is floated off.

One of these, from which very good results were claimed, is shown on the next page. It consists of a large rectangular tank, in which the water-level is kept constant by make-up water, if needed. The oily water enters at one side, and, after separation by gravity, is drawn off purified from below the surface on the other side, the separated oil overflowing from the top and the heavier sediment settling to the bottom. Make-up water was delivered into the right-hand chamber through a ball cock, the floating ball being set so as to keep a slight continual overflow of water when the plant was in operation.

Although this has given very good satisfaction, the owner states that it requires frequent cleaning, and a deposit of sticky oil is found to adhere to the entire surface.

Almost every conceivable adaptation of filtration has been tried for the removal of oil, both from the exhaust steam and from the water resulting from its condensation. For successful filtration two things are most essential—*viz.*, a slow passage of the fluid through the filtering material and frequent cleaning of this medium. These conditions are most difficult to obtain in practice, and many of the failures are largely due to the lack of these essentials.

Water from the hot well or the returns of heating mains is often led through sand as a filtering medium, the closed or pressure type of filter being usually used for this purpose, although large open filters are also sometimes found. The first water that passes through this bed of sand frequently carries oil with it, but, as some oil is retained in the sand, the free passage of the water is more obstructed, and good results are obtained. Finally, the deposit becomes so thick that the water

flows through with great difficulty, and the filter-bed must be cleaned. In some forms of filter cleansing is effected by reversing the current. The strong reversed current causes the bed to turn over and over, and the particles of sand are freed from their clinging deposit.

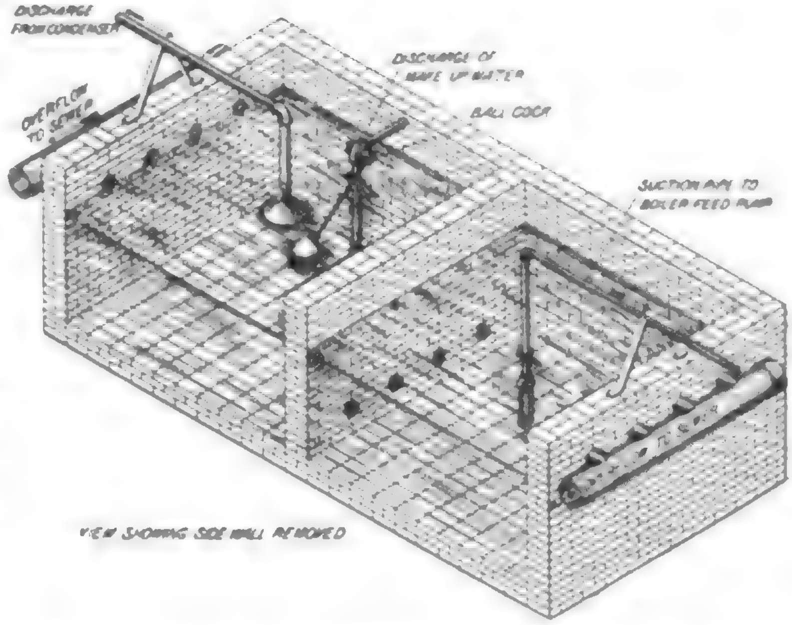


FIG. 1. HOT-WELL ARRANGED AS AN OIL-SKIMMING TANK.

The oil thus separated passes up to the top of the filter, where it escapes through vent cocks, and the action is thus continued until the escaping water runs clear. During this operation of cleaning the supply of condensed water is either shut off, or sent on to the boiler through a by-pass, although in some plants a second filter is in operation while the first is being cleaned.

Almost every conceivable filtering material has been used to remove oil. In marine practice, the water from the condenser is sometimes passed through long iron boxes tightly packed with sponges, two being generally used alternately, as they require very frequent cleaning to retain their efficiency. The dimensions given for this filter, for a 2,000-horse-power engine are, for each of the two boxes, 18 in. in height, 2 ft. in width, and 12 ft. in length, with open tops. The water passes through them longitudinally. Many steamers on Long Island sound use hay, straw, or excelsior for a filtering medium to remove the oil, with very good results, but small particles of these materials sometimes accompany the water as it leaves the filter, and cause trouble by getting on the seats of valves or by clogging passages.

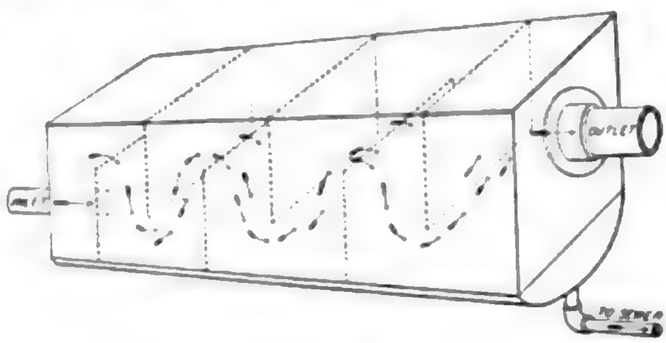


FIG. 2. COKE-FILLED STEAM WASHER.

Filter cloths, felt, common bagging, carpeting, and even blankets

have been used to get rid of this most troublesome impurity. The filters so far discussed handle the water, but the steam itself may be filtered. A very ingenious arrangement for this purpose, devised by an old marine engineer, consists of a rectangular box built of 2-in. cypress planks. It is 4 ft. wide, 6 ft. deep, and 10 ft. long. A number of baffles are slid into grooves so as to make the steam pass under one and over the next as it travels the length of the box. The exhaust steam-pipe enters one end, and passes to the condenser out of the other. This box is filled with ordinary coke. The bottom is perforated with many holes, which allow the arrested water and oil to drop into the inclined trough fastened below the bottom, whence they are discharged. When the coke becomes too foul for use, the baffle plates are drawn out of the box, and the coke is shoveled out and fired under the boiler, new coke being put in the box to replace the old.

Another method for the removal of oil from the steam is based upon intercepting the minute globules as they pass through a certain space. In one apparatus used, the exhaust is conducted into a large vertical cylindrical tank, entering it on one side and leaving from the other, the passage being obstructed by a number of inclined angle-irons, arranged in a staggered position and with their open sides facing the entering steam.

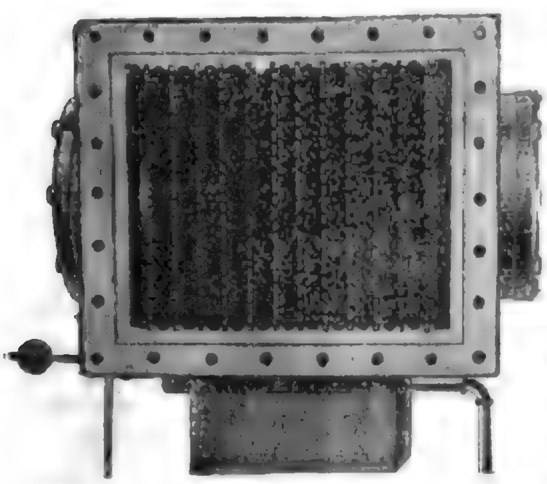


FIG. 3. INTERCEPTING OIL-SEPARATOR.

The intercepted particles of oil and water travel down the length of these angle-irons, and fall into a receptacle at the bottom of the cylinder, from which they are drained into the sewer.

A more compact form of intercepting apparatus employs a series of vertical screens, made of fairly heavy wire cloth flattened under considerable pressure, which are slid into top and bottom grooves. The mesh of these screens is varied to suit the service, but in no case is the combined area of openings allowed to be less than twice the area of the pipe. A very desirable arrangement is obtained when the screen nearest to the entering steam is of a small mesh, which breaks up and subdivides the current of steam very thoroughly, the next being of considerably larger mesh, and each successive screen towards the point of exit showing a further diminution in size of openings. The intercepted globules of oil and water pass into the receiver below, and

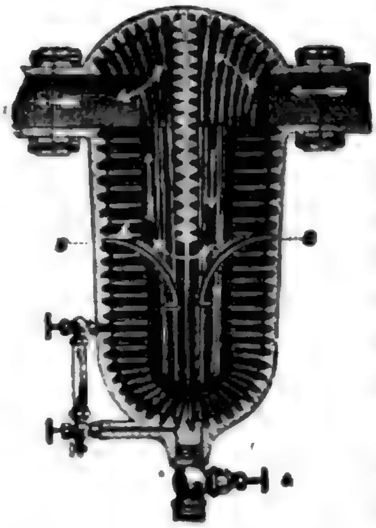


FIG. 4. BAFFLE-PLATE OIL-SEPARATOR.

thence are discharged. From time to time the screens are removed and cleaned. Figure 4 illustrates another form of apparatus, which is placed in a horizontal exhaust pipe, the arrows indicating the course traveled by the steam. An interfering central diaphragm throws the steam back upon the corrugated surfaces lining the interior of the entire chamber, to which a large percentage of the oil and oily water adheres.

Mr. W. J. Baldwin has long been working toward the same end along entirely different lines, his method being to blow the exhaust steam upon an extended surface of water; to increase considerably the size of the exhaust passage at this point, so as to materially decrease the velocity of the traveling steam, and thus cause it to drop much of its entrained matter; and, thirdly, to change the direction of the current. An apparatus of this description is now in use in some of the office-buildings in New York, and in many cases is giving good satisfaction; the construction is apparent from the figure.

The impossibility of affording the large space required by this apparatus in many plants led Mr. Baldwin to devise the form shown in Figure 6, and further improvements have made it more efficient than the large tank just described. The apparatus is essentially similar to the simpler form, but adds a series of dams (E D), past which the oil film is blown by the entering steam, and behind which it gathers at C, leaving under the entering current a clean water-surface, which is much more efficient in entrapping the entrained oil.

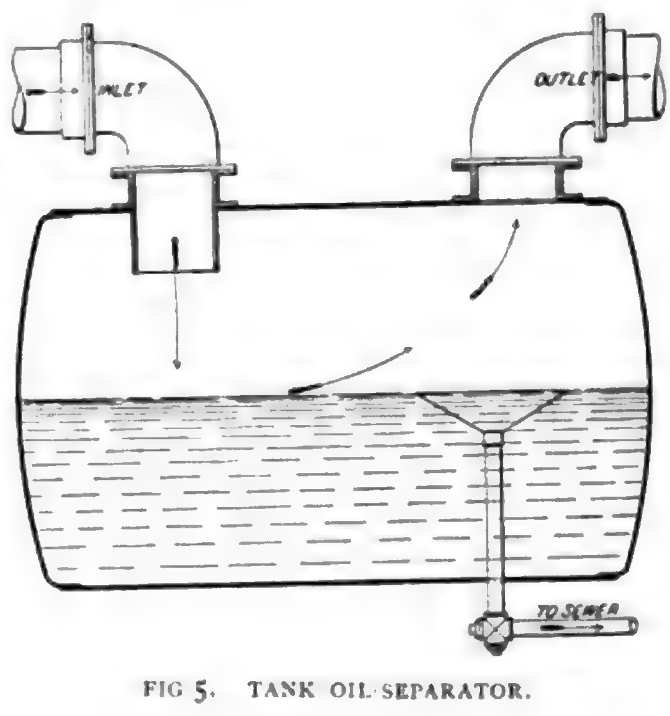


FIG 5. TANK OIL-SEPARATOR.

Another and still different apparatus for the removal of oil from steam is known as an oil-washer (Figure 7). This is a vertical cylin-

drical tank, containing a number of tubes. None of the tubes continued from one tube-sheet to the other. From the upper sheet a number of tubes drop to within about six inches of the bottom, while from the lower tube sheet an equal number point upward, measuring about fifteen inches long. These lower tubes determine the height of the water-level, and, of course, the upper tubes are immersed below this water-level some nine inches. The exhaust steam enters the chamber above, passes down the upper tubes, and escapes below the surface of the water. As it bubbles upward, the water washes out its oil and other impurities, and it passes out from the exhaust outlet located near the top of the chamber. Sufficient condensation takes place to keep up a continual overflow of water and oil, which pass down through the lower tubes into the drip-chamber below.

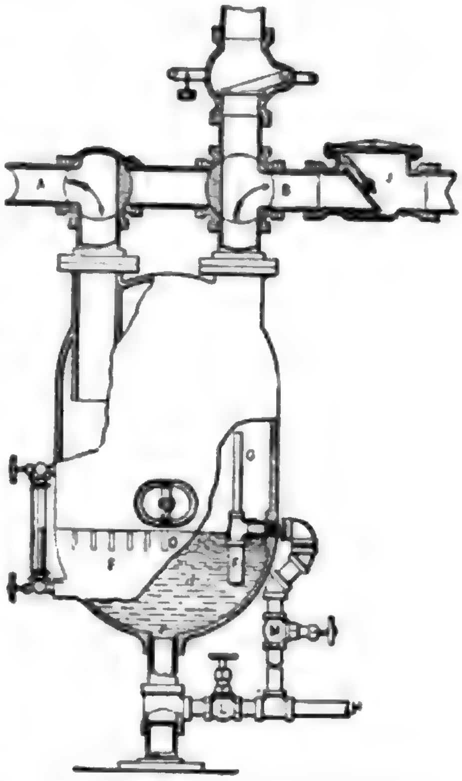


FIG. 6. BULB OIL-SEPARATOR.

In all apparatus requiring oily water to be drawn off through pipes, the greatest care must be observed to prevent these pipes from being stopped by the deposits of oil, which are sure to form within them. The pipes used should be some three or four times the diameter that would ordinarily be chosen, and at every turn and bend tees should be placed where elbows would ordinarily be used, and crosses should be substituted for tees. The unused ends of these fittings should be closed by brass plugs, which can be removed easily for inspection and for cleaning out the pipe; and every other possible provision should be made to facilitate such work.

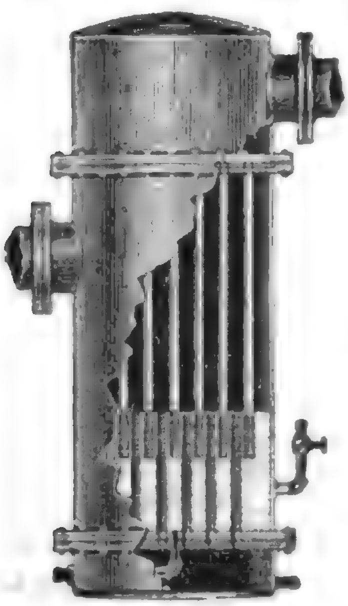


FIG. 7. STEAM WASHER.

The question is often asked: how much does a deposit of scale in boilers interfere with the transmission of heat to the water? the object being to determine the additional amount of fuel required when such a deposit has formed.

After a careful search in all directions, I

am still unable to find a satisfactory answer to this question. A number of experiments have been made to gain information on this subject, but, judging from the reports, either they have been conducted carelessly, or certain most important information has been overlooked or omitted. It may be discouraging at the outset to learn that this whole subject of heat-transmission through intervening substances is but imperfectly understood, even in its simplest form, such as the transmissionthrough clean plates. Authorities do not agree as to whether the rate of transfer of heat through the heating surfaces of boilers varies directly, or as the square of the difference in temperature of the heated gases and the water; some even hint at far more complicated laws.

That a difference does exist in the rate of transmission as the temperatures on the two sides of the intervening substance change is beyond all doubt. It changes also with the thickness of the intervening material, but much depends upon the nature of this material and its condition; for instance, glass will transfer heat much more readily than will the fine sand into which we can crush it. Owing to lack of positive information on this subject, some of the wildest statements have been made regarding the transmission of heat through scale of different thicknesses. One table has gone the rounds, and has been quoted again and again by some of the best authorities, in which is stated that scale $\frac{1}{16}$ of an inch thick will increase the quantity of fuel required 15 per cent.; $\frac{1}{4}$ of an inch, 60 per cent.; and $\frac{1}{2}$ an inch, 150 per cent.

This table is supposed to have originated with Prof. J. G. Rogers, of Madison, Indiana. It is barely possible that he may have obtained the first two figures by experiment with a certain kind of boiler scale, but such figures are very seldom obtained in boiler practice; in fact, I have found scale in boilers one inch thick, where no great difference has been noticed in the amount of fuel used. This scale was merely a light and very porous carbonate of lime, through which water and steam had very little difficulty in passing. The reader must not think, in consequence of what has just been said, that all scale deposits affect fuel-economy so lightly; my object in citing extreme cases is merely to show that there is a very wide difference in the effect produced in boilers with different kinds of scale, and that no one table can possibly express what this effect is with all kinds of scale.

Probably the earliest experiments on record for determining the effect of scale in boilers were made by John Graham between 1850 and 1860. These are described in "The Memoirs of the Literary and Philosophical Society" of Manchester, England (1860). In this paper Mr. Graham states that "a scale of sulphate of lime $\frac{1}{16}$ of an inch thick reduced the efficiency 14.7 per cent."

Experiments were conducted at Sibley College, under the direction of Prof. R. C. Carpenter, every precaution being taken to secure accurate results. The object of these experiments was to determine the heat transmitted in thermal units for each square foot per hour and per degree of difference of temperature. The apparatus used was a square box, in which a cast- or wrought-iron plate could be tightly fitted half way between the top and bottom, so as to form two separate chambers. The upper chamber held water, while steam was admitted to the lower. Thermometers inserted in these chambers showed their respective temperatures. The following results were obtained :

1 Difference of temperature of the two sides of the plate Deg. Fahr.	2 Clean wrought iron, $\frac{5}{16}$ inch thick.	3 Clean cast iron, $\frac{7}{16}$ inch thick.	4 Wrought iron plate and scale $1\frac{1}{8}$ inch thick.	5 Cast iron plate and scale $1\frac{3}{8}$ inch thick.
25	28.8	21	2.7	1.8
50	60.0	48	5.5	3.6
75	96.0	84	8.2	5.4
100	150.0	127	11.0	7.3
125	228.	185	13.7	9.1
150	348.	255	16.5	10.9
175			19.2	12.7
300			22.0	14.6
400			33.0	21.9
500			44.0	36.2

The figures given in columns 2, 3, 4 and 5 show thermal units transmitted per square foot, per hour, and per degree of difference of temperature. The scale used in these experiments, unfortunately, was not analyzed. It was taken out of one of the boilers of Cornell University, and was very neatly fitted in the box, on top of the iron plates, so that the heat was obliged to pass through both.

Prof. Carpenter, in speaking of these experiments in his work on "Heating and Ventilation," says: "The results of these experiments show that the amount of heat transmitted does not depend so much upon the kind of metal as upon the media in contact with the metal on both sides." He follows the results of his experiments given above with other figures showing results obtained when, instead of steam and water, oil and water and air and water are used. The results being different, it is fair to infer that, had a flame been brought in contact with the lower surface of the plate (instead of steam), still different results would have been obtained.

Without a doubt no other scale produces so disastrous results as those produced by an oil or grease scale.

M. Hirsch experimented considerably to determine the effect of this scale, concerning which he states that the difference in tempera-

ture between internal and external surfaces is 90 degrees above that of the clean plate for an evaporative rate of 32 pounds per square foot per hour, and more than 360 degrees for an evaporative rate of 51 pounds, the latter degree of overheat being dangerous. In other experiments, even at moderate evaporative rates, not exceeding 35 pounds, the temperature of the external surface of the plate was 856 degrees,—greater than the melting-point of zinc.

Mr. A. J. Durston, engineer-in-chief in the British navy, conducted a series of experiments in 1892 to ascertain the loss of efficiency in the heating-surface of tubes in a boiler, due to a thin coating of grease deposit. For this purpose he had a tube taken out of a new ship and cut in lengths, each of which was tested by surrounding it with water (in an iron box), and applying heat inside of the tube by means of gas-jets. These experiments showed that the thin coating of grease deposited on these tubes during the ship's trial caused a loss of efficiency, as heating-surface, as compared with a perfectly clean tube, of from 8 to 15 per cent., the mean of many experiments giving 11 per cent. In another series of experiments Mr. Durston used a flat circular iron plate with the edges flanged, so as to form a circular dish 24 inches in diameter, 2½ inches deep, and ¼ inch thick. A constant water-level was maintained. This vessel was placed over a forge fire. With a moderate blast the temperature of the hot side of the plate was found to be 240 degrees, when fresh water was being boiled.

These temperatures were determined by the melting of various alloys of different metals, attached to the bottom of the vessel.

When more blast was applied, the temperature of the plate increased to 280 degrees. This was with a clean plate and with clean fresh water, when the temperature of the fire was 2,200 degrees. When this experiment was repeated after coating the bottom (inside) of the vessel with a greasy deposit 1-16 inch thick, the temperature on the hot side of the plate was found to be more than 550 degrees with a fire temperature of 2,500 degrees.

We now come to a most interesting branch of the subject,—namely, the treatment of scaling impurities, either by removing them entirely, or else by changing their character in such a way that they become much less troublesome.

Owing to the unfortunate fact that boiler-users have been, as a general thing, too busy to give this important matter of scale and corrosion a proper amount of study, they have become the victims of more impostors than exist in almost any other branch of trade. The boiler quack comes along with his remarkable boiler compound, fluid, or special apparatus, and, without the slightest knowledge of the character of the impurities held in the water used in your boiler, he offers

his panacea with a long list of letters of recommendation, written often by the heads of concerns who are far better acquainted with the financial end of their business than with the steam apparatus. These gentlemen generally depend upon what their engineers or other employees tell them. The writer knows of not a few cases where the unscrupulous venders of these compounds share some of their profits with the engineers, firemen, or other influential employees, which they can well afford to do, as the stuff they sell seldom costs them a quarter of what they get for it. These unscrupulous people, their methods, and their wares have been "shown up" from time to time in the technical papers, and they have not escaped the well-directed fire of the Hartford Steam Boiler Inspection and Insurance Company.*

They are often very tricky manipulators, able to give an apparent exhibition of the wonderful disincrusting power of their purges.

I caught one at one time cracking the scale out of a boiler by blowing it empty of its water under steam pressure, and then flooding it suddenly with cold water. Of course, this sudden contraction caused the scale to crack off and fall, but a boiler-maker was kept busy for some time afterwards in making the boiler tight. This is but one of the many tricks resorted to.

The best advice I can offer on this subject is: Never use any boiler compound, fluid, powder, or whatever else, unless you know positively just what it is composed of, and how it will affect the impurities in your boiler-water or the boiler itself. Many of these quacks pretend to have made a chemical analysis of the water to be treated. This is often a mere farce, as the same old compound is trotted out on all occasions. Some submit to their proposed victim what purports to be the analysis of the water. Many a time a subsequent *bona fide* analysis, made by competent chemists, has proved to me the absolute worthlessness of these first supposed analyses.

The reader must not understand that every boiler compound or powder on the market is a fraud; a few of them are highly beneficial when used with certain waters, which their makers frankly describe or specify. In the treatment of boiler-waters, always start with a careful analysis of the water, made by a competent chemist who has had experience in this line. Next, if you are thinking of using any chemical that has been offered for treatment of your boiler-water, let your chemist analyze it. If you are dealing with straightforward people, they will generally tell you the exact composition of their material, which your chemist can verify easily, after which he will be prepared to advise properly.

There are, besides these compounds, fluids, and powders, num-

* *The Locomotive.* See Vol. V, page 59, and Vol. XV, page 50.

berless mechanical devices offered for handling the impurities in the feed-water. Some of these are effective, while many others are worse than useless; expert advice should be obtained before adopting them at the risk of an accident more or less serious.

Impurities may be removed from boiler-waters by mechanical treatment or by chemical treatment. Under the former heading probably the best known method of getting rid of these impurities after they have been precipitated on the boiler is by use of the blow-off cocks. Considerable mention has been made in the preceding pages of this indispensable boiler adjunct, and the reader will remember that both the "surface blow" and the "under blow" have been referred to.

When suspended matter settles in boilers, it is generally deposited near the discharge-end of the feed-pipe, or else (more frequently) where the circulating currents are the weakest; thus, in the case of horizontal shell boilers, we find the largest deposit on the bottom at the rear end, and therefore the under blow-off pipe is usually attached at this point. By opening the blow-off cock at frequent intervals a great deal of this deposit can be gotten rid of while soft. Bottom blowing, as this is sometimes called, is frequently conducted with little regard for existing conditions. Those in charge of boilers using bad feed-water often blow off their boiler but once a day, or twice a week, or at some other long interval of time, regular or irregular. They seem to think that, after a long lapse of time, all they have to do is to open their blow-off cock, and keep it open until the water runs clear. But they succeed only in drawing out the soft matter precipitated in the immediate vicinity of the blow-off opening, while the deposit but a short distance away is left comparatively undisturbed. Blowing off several times a day (where the precipitation is sufficient to warrant it), and opening the cock but a few seconds each time, will produce far better results than blowing less frequently and longer, as this method will remove the precipitate as fast as it forms in any appreciable quantity and before it has a chance to form into a hard scale.

The discharge pipes from many blow-off cocks are connected into other piping or tanks in such manner that the discharge cannot be seen, and therefore the time for closing is purely a matter of guesswork; the result is either a foul boiler, from insufficient blowing, or else a waste of too much hot water, due to blowing too long. The usual method of proceeding in such cases is to blow off the boiler at stated intervals (depending upon the purity of the water), until the water-level in the boiler falls one or two gages. Subsequent inspection of the interior of the boiler will show whether sufficient time has been allowed; if no scale be formed, the quantity of water blown off

each time can be reduced, and the next internal inspection will determine whether the blowing-off has been regulated rightly.

When the deposits in the boiler are due to mere concentration of the solution, precipitation taking place when they become supersaturated, the quantity of water blown off should contain a quantity of salts equal to that contained in the introduced feed-water.

Numerous devices have been invented to increase the area affected when the blow-off cock is opened. By one arrangement the blow-off pipe projects up through the bottom of the boiler, and has a T-fitting screwed on its end. From each of the two openings a piece of pipe projects, one running towards the front of the boiler and one towards the rear; the ends of these pipes are closed, but they are perforated on their under sides, so that the dropping precipitate will not tend to close the openings. When the blow-off cock is opened, the mud-like material is drawn into all of these under openings, thus accomplishing the required result. In some boilers a catch-plate is arranged to receive all the falling deposit. This is placed an inch or two above the bottom sheet of the boiler, and blow-off connections are made to its upper surface.

When the blow-off pipe is connected directly to the bottom of the boiler shell, the area affected when the blow-off cock is opened is comparatively small. Many people seem to think that, when this discharge takes place, all the impurities on the bottom of the boiler must rush out, but this is not so. The only area cleared is included in a circle concentric to the pipe-opening, and is very limited in diameter. This is well illustrated in the case of a sink containing water laden with impurities. When these impurities settle and the stopper is pulled out, it is impossible to drain off the settling, especially if the water-level be kept constant.

Thus far very little has been said of "surface blowing," which is, in many cases, as essential as "bottom blowing." Many of the materials held in chemical solution when precipitated first appear as a scum on the surface of the water. Oil also floats, and so do some of the lighter materials held originally in mechanical suspension. By use of the "surface blow" we are able to skim from the surface of the water a large percentage of these

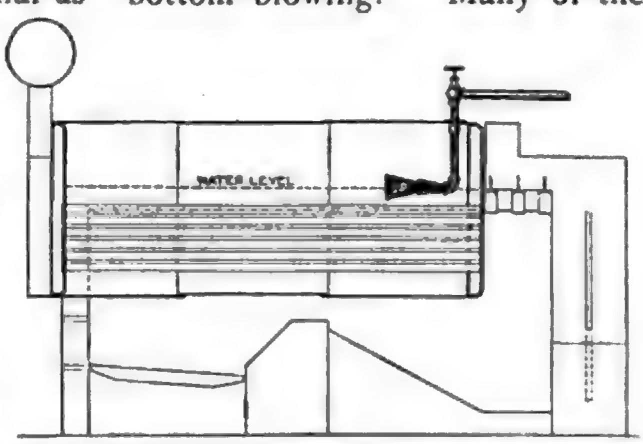


FIG. 8. SURFACE-BLOW-OFF, SHOWING COLLECTING-FUNNEL. SIDE VIEW.

materials before they have a chance to settle. The Hartford Steam Boiler Insurance Company show a very effective form of collecting-funnel in the *Locomotive*, which is reproduced in Figs. 8 and 9. This funnel, it will be seen, extends pretty nearly across the width of the boiler at the water line. When the valve is opened, the pressure in the boiler drives the water and steam up along the vertical pipe, and so on to the place of discharge, carrying with it all its floating impurities.

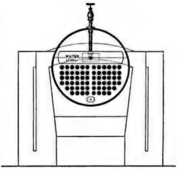


FIG. 9. END VIEW OF COLLECTING-FUNNEL FOR SURFACE-BLOW-OFF.

There are a number of automatic skimmer devices on the market, which are arranged so as to keep up a continuous circulation of water through a settling-chamber or a filter, where much of the impurities are retained, the clarified water being returned to the boiler.

A well-known form of one of these apparatus is shown in Fig. 10. The settling-chamber is placed above the boiler. When the valves H and H are opened, steam rises through both pipes (the valve F at first being open to allow escape of air) until it fills the chamber B. This steam condenses, and, because of the partial vacuum thus formed, water rises and finally fills the chamber. Then the circulation begins, the dirt-laden water rising along the pipe D, and, after passing through the chamber B, where much of this sediment drops to the bottom, continues its course back into the boiler through the pipe E. The valve F is occasionally opened, which discharges the dirt from the bottom of the chamber B.

Another automatic skimming device, shown in Fig. 11, furnishes a continuous passage from the scumming-funnel through the sediment trap back into the bottom of the boiler. The lower connecting pipe is placed in the path of the hot gases, and, as it becomes heated, the water that it contains rises, establishing a circulation which causes the water from the upper surface to flow into the funnel,

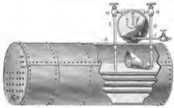


FIG. 10. AUTOMATIC CONTINUOUS SURFACE-BLOW-OFF.

carrying with it its floating sediment. The clarified water is collected from under the suspended bell shown, and returned to the boiler. Both of these apparatus have special arrangements for taking care of oil as it is drawn from the surface of the water, and it is claimed for both that they prevent foaming.

Probably no method of internal mechanical treatment is more widely known than the use of manual labor for the removal of scale after it has formed.

The character of the scale and its degree of hardness have a great deal to do with its treatment. Some scales are so soft that they may be easily swept out of the boiler or washed out by a stream of water, after they have been started away from the shell. Some are so hard that they actually resist the chisel more effectually than the metal itself, being either formed in close layers next to the shell or actually cemented to the metal of the boiler by corrosion or rusting.

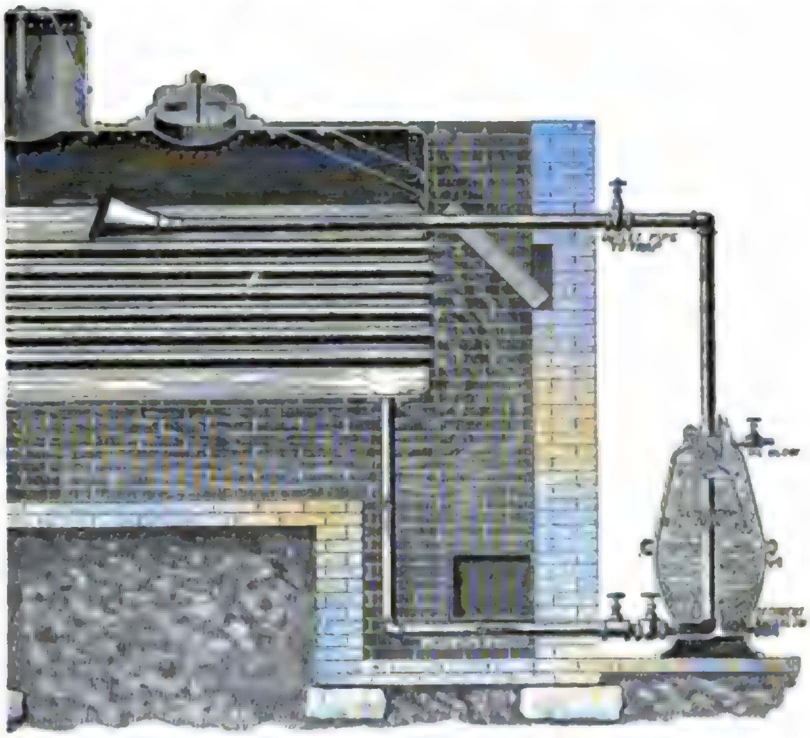


FIG. 11. AUTOMATIC CONTINUOUS SURFACE-BLOW-OFF.

These hard resisting scales have to be removed by vigorous chipping, the tools for this purpose varying from a common hand-chisel to a long rod with a chisel-like end, which is used like a battering-ram to reach inaccessible parts of the boiler.

Steel rods are sometimes bent on one end, like a shepherd's crook, the curve corresponding to the shape and size of the tubes. The operator takes a position on top of the bank of tubes, and reaches down between the spaces, hooking his tool around some scale-covered tube below, while a second man strikes the upper part of the bar so as to make it slide along, and thus scrape off the scale. In many boilers the best possible cleaning of this kind can be only an imperfect job. In water-tube boilers containing straight tubes cleaning can be most effectively done by means of scrapers and steel brushes, but,

where a long accumulation of scale has been allowed, a regular boring tool has sometimes been required to bore out the scale.

A great deal of damage can be done to a boiler by use of chipping-tools, as the surface of the metal is often chipped off along with the scale, laying open a spot for corrosion. I have also seen rivets and lap-joints badly battered with such tools, as well as braces, stays, and other boiler parts. There is no excuse for allowing a boiler to get into a condition so foul as to require this destructive treatment, and it will pay the owner many times over to consult an expert, who will soon be able to remove most of the cause of danger.

Another method of internal mechanical treatment introduces into the boiler certain substances which will coat the little precipitated crystals or floating particles of mud, etc., with envelopes which prevent them from coming in contact and adhering when they settle. Some of these form a mucilaginous mixture with the water. Slippery elm, starch, and potatoes are examples of this class. This kind of remedy cannot be considered desirable, as it frequently causes foaming, and any considerable deposit of this kind involves great danger from overheating of the plates. Another remedy of this kind, extensively used in this country, is petroleum, as well as kerosene oil. The petroleum oil has much more of this enveloping quality than the kerosene. Besides producing this effect on the unprecipitated scale matter, both have an active "rotting" effect on the scale already formed, the kerosene in this case being superior to the petroleum. Crude oil should never be used, positively nothing but carefully-refined oil, which has been deprived of its tar and wax, as these form a tough, impervious scale productive of bagging sheets and collapsed flues. Both petroleum and kerosene should be fed to the boiler with the feed-water, drop by drop, through a sight-feed apparatus, similar to those used to feed oil to the cylinders of engines.

Under no consideration should a large amount of oil be fed to a boiler at one time. The more volatile portion of the petroleum is distilled off quickly in the hot boiler, leaving the least efficient portion behind, while practically all of the kerosene is vaporized at once.

Where hard scale has formed in a boiler, it is sometimes most effectually treated by giving it a coat of petroleum. This may be applied with a brush, or squirted on. But an easier method of application is to first fill the boiler with water above the line where the oil is to be applied, run the oil in on the surface of this water, and then let the water gradually run out of the boiler, leaving the oil clinging to the interior surface. Kerosene is most effective in destroying the tenacity or coherence of this deposited scale, but it is dangerous to use, on account of the explosiveness of the vapor it gives off.

Great care must be taken, in using either the petroleum or kerosene in this way, to have no lights in the vicinity of the boiler, as men have been very seriously injured by lack of prudence in this work.

Another method of internal mechanical treatment is by use of interior scale-collectors, designed to fit inside of boilers, in the steam space, or just below the level of the water. Those placed in the steam space generally receive the feed-water in the form of a spray or a thin sheet, the object being to expose as large a surface as possible to the hot steam, thus causing the water to become heated quickly to a temperature that will precipitate the material held in chemical solution. This falling water is received sometimes in a funnel, in which the precipitated matter is supposed to fall to the bottom, while the clear water overflows to mingle with the water of the boiler. By occasionally opening a blow-off connected to the bottom of this funnel, the deposited matter is blown out.

In another arrangement the water enters one end of a long pan inclined in the steam space of the boiler. After coursing its way down the length of this pan, its course being constantly changed by a series of baffles, the water escapes from the lower end, and much of the precipitated scale-matter is supposed to remain in the pan in a position to be easily discharged through a blow-off pipe. Still another form of apparatus consists of a service of spill-pans, one placed above the other so that water enters the top pan and spills in a thin sheet, to the one below, the water thus continuing to the bottom. In apparatus of this kind, time, a most essential consideration, is not thought of. No precipitation can be perfect where a certain amount of time is not allowed. Another serious objection to the use of this form of apparatus is that the cold water is introduced into the steam space, thus abstracting its heat and producing wet steam.

The same objection may be raised to some of those apparatus located near, but just below, the surface of the water, as these devices, into which the cold water is being constantly introduced, form a refrigerating surface, which interferes with, and chills, the bubbles of ascending steam. One consists of a long pipe several times the diameter of the feed-pipes, placed at an inclination just below the surface of the water. The feed-pipe is run concentrically down this larger pipe, discharging near the lower end. As the feed-water is raised in temperature by the surrounding water, it is supposed to deposit much of its impurity in the larger pipe, from which provision is made to blow it out, by connecting a blow-off pipe to its lower end. In another arrangement of this kind a large pipe, four to six inches in diameter, is run, in a horizontal shell boiler, from one head to the other, passing through both heads, and having tapered brass plugs

screwed into the ends. The feed-pipe is run concentrically through the center of this large pipe, and has a series of slots one-fourth of an inch wide cut in it near the rear end of the boiler. The feed water escapes through these, and then has to pass back to the front end of the boiler along the larger pipe, where it escapes through slots, and mingles with the water in the boiler. From time to time, when the boiler is shut down, the plugs are taken out of the ends of the large pipe, and the internal feed-pipe is removed, allowing a thorough cleaning to be made. When the boiler is in operation, a blow-off pipe attached to the rear plug is opened from time to time to blow out the impurities.

A great trouble with many of these internal apparatus is that they are much in the way when the interior of the boiler is being cleaned or inspected, and often lead to bad work and to neglect. Another trouble is that they fill up with scale, etc., and thus become very ineffective, and sometimes even dangerous, and it is very questionable, with many of them, whether as good, if not better, results cannot be accomplished with properly-manipulated blow-offs.

We may next consider external mechanical treatment of the feed-water. Mention has already been made of settling the floating matter in big tanks or reservoirs, before using the water in the boiler. It will be seen later that water may be treated chemically in comparatively small tanks, with rapid precipitation and final settling of the impurities to the bottom.

On the principle that it will take the floating impurities in water but half the time to settle through a depth of six inches of water that it will take them to settle through twelve inches, settling towers have been devised containing a series of inclined shelves so arranged that a certain amount of water will fill one shelf and then spill over to the next one below, settling taking place on each of these shelves, from which the impure deposit can readily be run out. Probably one of the oldest of all known methods for removing floating impurities from water is the use of filters. These have been somewhat described under our treatment of oil in the water. Sand is probably more widely used than any other filtering medium, as it is less capable of becoming itself fouled, and its sharp edges, rubbing against each other when set in motion, have a very cleansing effect.

A perfectly clean sand filter-bed is seldom efficient to hold back the finer floating particles, but this bed soon collects a sufficient quantity of the larger particles, and, as these interfere with the freer flow of the water, they hold back the minute matter that formerly found its way through the bed. The efficiency of a filter depends upon the state of cleanliness in which it can be kept, and thus much depends upon ease of manipulation in accomplishing this purpose.

Filter presses are being most effectively used for removing the impurities from boiler feed-water, especially after this water has left a settling-tank. The filter press is constructed with a series of plates which have their outside frames carefully faced and fitted, so that the frames form water-tight joints where they come in contact one with the other, even under a considerable water-pressure. Filter cloths are placed between these plates, through which the water is forced by means of a pump. When it becomes necessary to clean the filter press, the plates are released by turning back the screw, and the dirty filter cloths are removed, new ones being substituted. The cloths can be washed over and over again, and thus the expense of manipulation is not great.

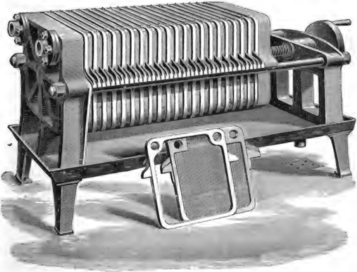


FIG. 12. A FILTER PRESS.

Heating the feed-water is a most important method of external mechanical treatment. Exhaust steam will cause a precipitation of most of the carbonates, but, when sulphates are present, the higher temperature of the steam from the boiler is required.

In one form of this apparatus, a cylinder placed horizontally contains a series of sheet-iron shelves arranged one above the other, so as to slide in from the end, which opens. These shelves are in the form of shallow U-shape pans. The feed-water is admitted into the top

pan, which soon becomes full and overflows into the pan below, and so the water continues until the bottom of the purifier shell is reached, when the water is conducted to the boiler. The live or exhaust steam, whichever is used, is admitted into one end of the shell, and finds an exit at the opposite upper end. The water is allowed to remain in these pans sufficiently long to precipitate the greater part of its impurities, and finally the pans, when filled and crusted, are taken out, cleaned, and returned to their places.

Another apparatus depending upon a similar principle for working is shown in Fig. 13. This is a vertical cylinder filled with corrugated iron shelves, upon which the deposit takes place in a way similar to that just described. The steam inlet is plainly shown, and just inside of the shell opposite this inlet is seen a herring-bone, ribbed plate, against which the exhaust steam is thrown with its contained oil. The oil is supposed to be retained by these ribs, and to finally drop to the space below. The steam then continues its passage among the corrugated shelves, and, after heating the water so as to cause a precipitation, escapes from the top of the cylinder. Another and a similar form of this apparatus is used with live steam. Claims are often made by the manufacturers of fuel-economizers and feed-water-heaters that their apparatus are water-purifiers. This is true only to a limited extent, varying according to the form of construction. The fuel-economizer is but a supplementary boiler, placed in the path of the waste gases, between the boiler and the chimney. The feed-water is made to pass slowly through the tubes, while the hot gases around them raise its temperature. This is the primary object.

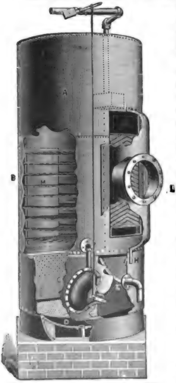


FIG. 13. EXHAUST-STEAM FEED-WATER PURIFIER.

Secondarily, the rise in temperature is generally sufficient to cause a precipitation of impurities from their chemical solutions, and a deposit in the tubes and headers.

With such a non-conducting deposit in the economizer tubes, of course the capacity of the apparatus for absorbing heat for its contained water is reduced. Hence, for the best working conditions, the water should really be purified before it is admitted to the economizer. Much the same comment can be made regarding most of the closed exhaust-steam feed-water-heaters, although there is seldom anything deposited in them that will form a hard scale. Crooked and bent tubes in these apparatus prevent the easy removal of the scale and the oil deposits. The open exhaust-steam feed-water-heaters receive the steam and water in the same chamber, where they are intermingled. The scale-making material is generally precipitated, in these apparatus, on shelves, in pans, or in some filtering material through which the water passes, and facilities, more or less perfect, are provided for cleaning these receptacles. Open heaters are, unfortunately, charged, from time to time, with introducing oil into boilers, this oil, of course, coming from the exhaust steam, which is condensed in the heater.

Turning now our attention to chemical treatment, we find that the most widely-known practice of this kind consists in feeding chemicals directly into the boiler, where they act upon the scale-making impurities. This, although very simple in manipulation, cannot be endorsed as good engineering practice. The boiler has all that it can do to discharge its primary function,—namely, to make steam,—without being used as a chemical laboratory and precipitating tank.

The principal object of this method of treatment is to change the character of the precipitated matter so that it will form a soft, instead of a hard, scale, which can be more easily removed from the boiler. Some chemicals also soften or "rot" old scale formations.

Some chemicals are introduced into boilers to neutralize acid waters, and these three results are practically all that are attained by this method of treatment. Is it a step in the right direction to put more solid matter into a boiler than is originally contained in the feed-water? Is it not far more rational to remove this scale-matter from the water before introducing it into the boiler? We have already seen that this can be, in great measure, accomplished. The expense of equipping a plant with these more refined methods, or the lack of room in which to place the apparatus, sometimes forces the adoption of the cruder method of treating the water in the boiler with chemicals. The more refined methods are used far more abroad than in America, and I believe that, before many years, we shall wake up to the fact that an investment in a good purifying plant for boiler-waters will be as good an investment as can be made on the steam plant. With impurities constantly entering the boiler, its efficiency begins to decrease from the day that it is started.

Why not keep the boiler up to its original efficiency and ability to "steam easy," and save coal by keeping the boiler continuously clean?

The boiler quack is at his best when selling his mixtures for treating the water inside of the boiler. I have already named the principal chemicals used for this purpose. All are very cheap. Tannic acid, in one form or another, is often used, but an excess of this is dangerous in a boiler.

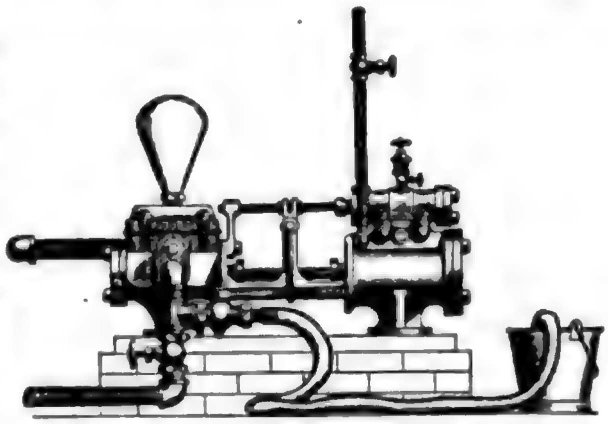


FIG. 14. PUMP CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

Solids (powders, etc.), should never be introduced directly into a boiler. They should always be dissolved entirely, and the solution only should be used. I have found solids of this kind deposited in masses, and in most dangerous positions.

Three most effective methods of introducing solutions into boilers are illustrated * in Figs. 14, 15, and 16. In Fig. 14 it will be seen that the solvent is put into the pail or tub, from which it passes through the suction-hose and plug-cock into the main suction-pipe of the pump. In Fig. 15 the suction-tank is placed over the pump, and, when the valve below the receptacle is opened, the solution passes into the pump. Fig. 16 shows an arrangement by which an injector can be made to pick up the solution and feed it to the boiler.

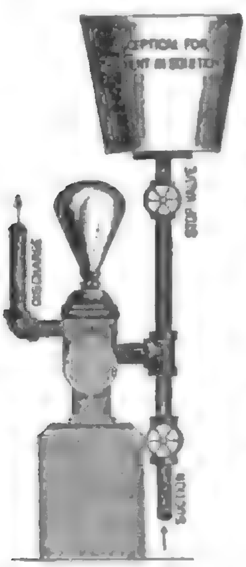


FIG. 15. PUMP CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

The fundamental process for treating water chemically outside of the boiler is the Clark process, described in the second article of this series. For this process, two or more tanks are used, each of which will hold at least six or eight hours' water-supply.

The "raw" water is first treated in one tank. After it has been thoroughly mixed with the chemicals a precipitation takes place, the scale-making material falling to the bottom of the tank. This settling requires from six to ten hours, and then the upper water in the tank is ready for use in the boiler. While this is being used, water is being similarly treated in the adjoin-

* Reproduced from *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company.

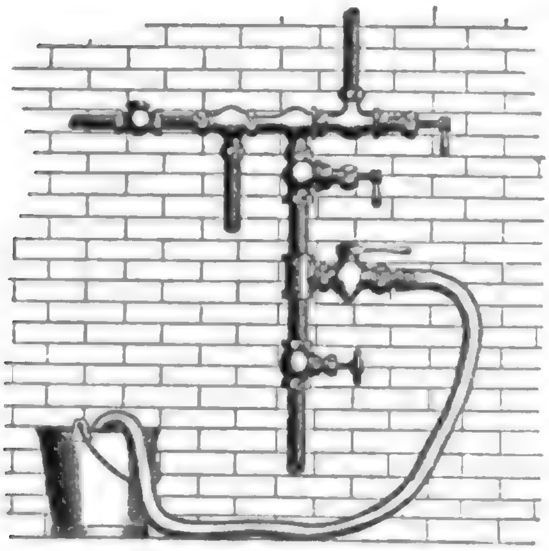


FIG. 16. INJECTOR CONNECTIONS FOR FEEDING SOLUTIONS TO THE BOILER.

ing tank, and thus this process is continued. The "mud," or precipitated matter, is easily removed, from time to time, from the bottom of the tank, by brushing or washing out with a hose.

A Cincinnati concern, manufacturing one form of apparatus for this process, places a special stirring device in the bottom of the tanks, similar to a propeller with a number of blades.

The "raw" water and the solution are thoroughly mixed by turning this mixer, and, besides, the previously-deposited precipitate is stirred up and mixed with the water. This has proved a valuable process, as the old precipitate settles much more quickly than the new, and drags the new down with it.

After the settling, a pipe is arranged so as to draw the water from near the surface only, while the precipitation is being completed beneath. This pipe is hinged near the bottom of the tank, while the free end has a float attached, which rises and falls with the variation of the water level. After this settling, a little sediment is still found in the water, but this is removed by passing the water through a filter before sending it into the boiler.

Enough has been said to show the reader that scaling and corrosion in boilers are not necessary evils, and, further, that the treatment of boiler feed-water is a purely engineering and chemical problem, capable of being handled in a thoroughly scientific and practical manner, without guesswork or the use of the rule of thumb.

In the selection of boilers, many have considered the quality of the feed-water one of the governing factors, and have, in consequence, advised, where bad feed-water is obtained, the use of boilers known to be the least economical of all that can be found in the market.

Surely this is not in accordance with the progressive ideas of to-day.

The best and most economical boiler that the market can afford is none too good for any steam plant. If the feed-water proves bad, let it be treated properly. In this way only can a steam plant compete with its neighbors successfully.

REVIEW OF THE ENGINEERING PRESS

The Floods of 1897.

THE damage done by the floods along the Mississippi river, notwithstanding the immense sums that have been expended to keep this wayward stream within bounds, has reopened discussion upon the great engineering problem of restraining it and similar streams from overflow, even when carrying in their channels extreme volumes of water. The discussion has been general, not only in the technical engineering press, but in publications devoted to miscellaneous literature (*Harper's Weekly*, April 17) and to finance (*Bradstreet's*, April 17). *Bradstreet's* advocates the reinforcement of the Mississippi banks under national direction, and shows some of the disabilities attending the levee system. It quotes from a southern newspaper to show that "the flood of a single season is capable of creating loss and damage, in some half dozen States, of hundreds of millions of dollars. This is too much for a great continental river carrying the waters of half the union to be permitted to inflict, at a single blow, on the people of the southern lowlands." It also quotes a correspondent of the *St. Louis Globe-Democrat* as voicing the general belief in the inefficiency of the present levee system. The correspondent referred to, after a trip through the valley from Cairo to Vicksburg, says that "the consensus of opinion of the steamboat men, planters, and residents of cities is that 'the levees must go.'" He adds that the exceptions to this view he finds among government engineers and the members of the levee boards. "Even they," he says, "admit that the levee system has proved a failure this year, so far as giving protection to the lands behind them is concerned, and the only defence they can offer is that the high water of 1897 is without precedent, so that no calculations based on the conditions of previous years could be taken into account in coping with the floods. The attempt to confine the river within narrow banks by means of levees, where successfully done, might be defended at least on the ground of its success. When, however, this plan is tried, as it was this year, and fails, and the immense power of the water for evil is accentuated by every attempt to confine it, then the evils of the levee system are brought more directly in evidence." Speaking of the belief by the planters in private levees about the few acres included in their orchards, gardens, and plots of ground surrounding their homes and the homes of their employees, he says that the value of the overflows in fertilizing the lands is acknowledged, and that the prehistoric mounds along both sides of the river have probably been utilized in effecting this purpose. He intimates that this may have been a use for these mounds hitherto unsuspected by antiquarians. In the article upon this subject, *Bradstreet's* evidently favors national supervision of this river. *Harper's Weekly*, in a very interesting article describing the floods at various points along the river, and their effects, says that, "notwithstanding the tremendous damage done by the present flood, it will probably be found that the element of safety along the Mississippi river system has been increased of late. In the flood of 1882 the total number of crevasses was 284, aggregating 56.09 miles in width; in 1883 the crevasses numbered 224, with an aggregate width of 34.1; in 1884 the crevasses numbered 204, aggregating 10.64 miles in width; in 1890 the crevasses numbered only 23, aggregating about 4.25 miles in width; in 1892 and 1893 the percentage of breaks is said to have been less than in 1890. In the flood of this year the serious breaks thus far do not number more than eight or ten, the chief of which—that at Flour Lake, Mississippi—has caused so much devastation in the Yazoo Delta." Further light is thrown upon the disabilities of the present system of constructing levees under State supervision by a further statement in *Harper's Weekly*, referring to the work of the

Mississippi river commission, which has been in existence since 1879, and has spent large sums of money on improvements. "It was found that in many of the levees constructed by the States corruption had been potential, and that, as a result, the levees would give way in time of a great flood. There was also no harmony between the various States as to the system of constructing levees. Arkansas, for example, was found to be indifferent to Louisiana's welfare. It became necessary for Louisiana to go into Arkansas territory, by permission of that State, and to locate levees for the protection of Louisiana. The latter State, of course, could not police these levees in Arkansas. All of this showed the need of intelligent coöperation between the States in the proper development of the great river's resources, and the protection of the vast commerce that lies along its great length. It will be read with surprise that there are several hundred miles along the river without immediate levee protection." One of the important engineering facts developed by the study of the problems presented to the river commission is that the opinion formerly held that the elevation of the levees was followed by the elevation of the river's bed is erroneous. The exact reverse is the case. With high, firm levees, the river scours itself out and deepens its channels in times of flood.

Impure Water and Disease.

A DOUBLE number (March and April) of the *Albany Medical Annals* deals almost wholly with a discussion organized by Dr. Henry Hun, at the request of the president of the Medical Society of the State of New York, and held at the meeting of that society in January of the present year. The papers which make up this able discussion represent the most advanced views of physicians, chemists, and bacteriologists on the relation of impure water to disease, and the cure and prevention of such diseases as are disseminated by contaminated water. The breadth of the discussion is indicated by the titles, and the names of the authors, of the papers: "Common Causes of the Contamination of Drinking Water," by Timothy Matlack Cheesman, M.D.; "Diseases which can be Directly Traced to Contaminated Drinking Water," by George Blumer, M.D.; "A Statistical Inquiry into the Relation between Contaminated Drinking Water and Typhoid Fever," by John S. Billings, M.D.; "Danger of the Domestic Use, Other than Drinking, of Contaminated Water," by Rowland Godfrey Freeman, M.D.; "Water Purification," by Thomas B. Carpenter, M.D.; "Methods of Preventing the Pollution of Water," by Edward K. Dunham, M.D.; "Life History of the Typhoid Fever Germ Outside the Body," by F. C. Curtis, M.D.; "Bacterial and Allied Tests as Applied to the Clinical Diagnosis of Typhoid Fever," by John Slade Ely, M.D.; "Typhoid Fever in Infancy," by W. P. Northrup, M. D.; "Medicinal and Dietetic Treatment of Typhoid Fever," by William S. Ely, M.D.; "The External and Internal Use of Water in Typhoid Fever," by Charles G. Stockton, M.D.; "Disinfection of Typhoid Excreta," by Gilman Thompson, M.D.; "Discussion on Papers on the Pollution of Water," by Prof. William T. Sedgwick. It will be seen that the general subject is well covered by the papers on the special topics, and that many of these papers, particularly those on the purification of water, causes of contamination, methods of preventing pollution, and statistics, have a direct bearing upon the practice of municipal engineering, in which water-supply ranks next to drainage in importance. In short, we should think that this collection of papers ought to find a place in the library of any municipal engineer who wishes to bring his works of reference as nearly up to date as possible. Of course, it is impossible in a collective notice of so many papers to indicate the nature of each by reference to general or special features. We will, however, make one or two quotations that will justify the opinion we have expressed of the value of the collection. In Dr. Carpenter's paper we find the following conclusions:

"(1) Purification of water should be municipal, not domestic, because domestic filtration cannot be relied upon. (2) Domestic purification can be best obtained

by heating to 80° C., for twenty minutes. (3) All evidence available at the present time favors the superiority of 'natural' filtration for purification on a large scale. (4) With few exceptions all American cities furnish their inhabitants with water that is at least suspicious, and in most cases polluted. (5) A continued typhoid mortality of over 20 per 100,000 means a polluted water and a preventable sacrifice of human life." These conclusions are all sustained by facts, arguments, and statistics presented in the body of Dr. Carpenter's paper. Dr. John Slade Ely's paper on "Bacterial and Allied Tests" shows that, to positively prove or disprove the presence of the typhoid bacillus, the water must be subjected to the following tests (quoted from Loesener), which sum up an exhaustive examination of the literature of the subject.

"(1) The appearance of the superficial colonies in gelatine plates. (2) The very active motility. (3) The number of flagella originating from all parts of the bacilli. (4) Decoloration by Gram's method of staining. (5) Growth on media containing grape, milk, and cane sugar, without gas formation. (6) Growth in milk without causing its coagulation. (7) Growth in proteid—containing media, without generating indol. (8) Production of acid when grown in whey, but not in excess of three per cent. as tested by one-tenth normal soda solution. (9) The growth on potato. (10) The failure to grow in Maassen's normal solution with glycerin." Many other tests are named and described. A valuable feature of this paper is a bibliography of the subject.

Dr. Cheesman, in his paper, asserts that all waters obtained from the neighborhood of populous districts are to be regarded with suspicion. He also states the conditions most favorable to the multiplication of pathogenic bacteria,—to wit, a fluid abundantly charged with organic matter, protection from light, and favorable conditions of temperature. Unfortunately these are the very conditions to be found in many of the tanks used for storing temporarily the water-supply of dwellings. "Many of them may not have been cleaned out for years; others may have been more or less thoroughly cleaned once a year, and then, perhaps, under protest, by order of the health authorities. Such tanks are often built so that it is impossible to get at them to clean them at all. The presence of a single pathogenic micro-organism in such a cistern might result in its active multiplication and in a serious outbreak of disease."

Dr. George Blumer held that, if the cause of a disease can be isolated from the water, and if the great majority of the individuals attacked by the disease partook of the water, and if there is no other source of infection common to all the individuals attacked, this proves with certainty that the disease is caused by drinking water. Dr. Blumer is director of the Bender Hygienic Laboratory at Albany, a position which gives an authoritative character to what he says or writes upon the relation of impure water to disease; yet, as in the three proofs he names one is negative, we must disagree with him that they together establish a certainty. To establish a negative proof is a task from which the ablest logicians will shrink. We may prove that *C* exists as a factor, and that *D* in some form always accompanies *C*, but to show that some other unknown factor, the nature of which even is a mere matter of conjecture, does not also exist is indeed a task. We should be willing to admit that the three conditions named by Dr. Blumer establish a very strong probability, even a convincing probability, warranting belief and action, but we should not class such a probability among absolute certainties.

The Center-Court Apartment-House.

Our much-esteemed cotemporary, *The Engineering Record*, has been referred to in these pages several times as a pioneer in the movement for improved apartment-houses for working-people of small incomes; it has consistently maintained its support of this movement for many years. Under the above title it presents (April 3) an illustrated description of a center-court apartment-house, which, it is presumed, was thought worthy of the two pages of space

devoted to it. We are ready to admit that the design has some commendable features, but the pitiful meagerness of the room provided for each family impresses us very unfavorably. We are told that this building has been erected on West Twenty-eighth street, New York; that its purpose is for rental in low-priced apartments and ground-floor stores; that it is a semi-fire-proof structure; and that it was "designed with especial regard to the best utilization of space on an ordinary city site, the most convenient arrangement of rooms, and to secure the greatest amount of light and ventilation possible under the conditions." We are further told that the ground on which this structure stands is a fifty-by-one-hundred foot lot, and that the building is a five-story and basement apartment-house. Within this space are to be housed twenty-two families and three ground-floor stores. There is a court about nineteen feet square in the center of the building, which is open on the south, permitting free access of air, and, it is claimed, of sunlight to the very bottom; but as the opening from the ten-feet-wide yard at the rear into this court is only about three feet in width, it seems that direct sunlight can reach the bottom of the court for only a small part of each day, and that this claim is more fanciful than real. "The staircase halls are all lighted from top to bottom by windows on each floor, and have, in addition, ventilating skylights at the roof. To insure protection from fire, each tier of flats is entirely enclosed between brick walls, nowhere less than twelve inches thick, and it is thought probable that fire in any one section of this building could be prevented from spreading to any other section, as there are five fire-proof sections running from the first floor to the roof." Each of these sections may be shut off from the others by fire-proof doors. This is an excellent feature, which cannot be too highly commended. The first floor is constructed with iron beams and terra-cotta arches, as required by law, and the semi-fire-proof construction above this floor is claimed to be much better than the law requires. The stair-halls have cement floors, and there are two ways of egress from each apartment. Hot water is supplied from the cellar, and the plumbing throughout is open. All of this is praiseworthy, and we are prepared to admit that the architects, a New York firm, have very nearly achieved the object of the design, so far as conditions permit, one of those conditions being that twenty-two families should be crowded into the space above the ground-floor stores. The class of tenants obtainable for apartments of this kind will not average less than four to each family; therefore, we may consider that eighty-eight persons are to be accommodated—exclusive of the stores—on a ground-plan of fifty feet by eighty-eight feet and nine inches, out of which the area in plan for walls and partitions is to be taken. Taking the dimensions of the rooms as marked on the plans so far as they appear, and ascertaining by the scale the dimensions—not given—of the bath-room and closet, we find that a floor-space of less than ten feet square is allowed for each person, or a little less than ninety-one square feet per person in the four rooms and bath apportioned to each family on the second floor. These rooms are a living-room, two bed-rooms, kitchen and bath-room, with a single closet for wardrobe about three feet wide by nine inches deep. The bath-room, which includes the water-closet, is four feet square; the kitchen, which includes range and wash-tubs, eight feet six inches by eight feet eight inches. Less than nine hundred cubic feet of space per person are allotted. It may be that this is the best arrangement that is possible for people who are expected to live (like rats in burrows) in spans just large enough to permit their turning around; but the crowding of eighty-eight people into a space like this is to us not a very encouraging outcome of all the effort that has been put forth, and we do not think it ought to be so regarded by the public. At the first, when new and clean, such a building would, perhaps, contrast favorably with the older tenement-houses, and in some ways it would always be superior; but nothing would prevent its ultimate degradation into a den of squalor,—perhaps, also, of vice.

Gold in Siberia.

To the issue of April 3 of the *Mining and Scientific Press* Mr. Russell L. Dunn contributes a very interesting illustrated article upon gold mining in Siberia. While gold mining has been carried on in Siberia for nearly the same time as in California, it remains in its methods and appliances almost the same as when it began. There are no advances of note. While Siberia is a very large country and a large gold-producer in consequence, it suffers very much in this respect in comparison with smaller countries. The gold-bearing regions are scattered over an area of about three thousand miles east and west by one thousand miles north and south; besides, there is the Ural district, from which, notwithstanding its small size, comes a large part of the total annual production of Siberian gold. Mr. Dunn writes from personal observation, and he considers that the gold-bearing territory extends from the Yenisei river to the Pacific ocean, and from the southern limit of the Amoor drainage and the Altais, northward, till the foot-hills disappear about the Arctic circle in the swampy plains bordering the Northern ocean. So far, the method of placer mining is the only system that has prevailed. Only the shallow surface placers, such as were worked in the river bars and foot-hill gulches of California by the early gold-seekers, have supplied gold from these regions. These placers are many and scattered widely, and a few only are exceptionally rich. Mr. Dunn believes that he has observed conclusive evidence of quartz-lodes whose value is not appreciated by the Siberian miners. These lodes are similar in character to the California quartz-lodes, and the placers are situated not very far from their source in these lodes. The prospecting of these placers involves the thawing of the earth by artificial heat, in those parts of the country in which the ground is perpetually frozen. After the placer is located, it is worked in what are called "shurfs" sunk simultaneously on the placer, two men working at each shurf together. These shurfs are about seven feet square, being excavations carried down to bed-rock at depths ranging from six to twenty-five feet. Fires are built along the surface, softening the ground to a depth of about seven inches for each firing. The softened ground is then removed by pick and shovel. "When gold begins to appear in the ground, each successive seven inches of softened wash is deposited by itself by the side of the shurf, and marked with a stake, giving its depth from the surface. The foreman or engineer prospects these saved layers, and finally, with a seventy-two pound sample, washed either in the Siberian *batea* (a shallow wooden bowl about 22 inches in diameter), or in the Siberian sluice (which has its nearest comparison in a mortar mixing-bed), determines the weight of gold that a unit of 3,600 pounds of the wash will contain. This he marks on a rough plan-map of the shurfs, and also marks the respective depths of over-burden and of pay. This washing is usually done in the following summer. If sufficient gold is shown to pay, on working, other intermediate lines of shurfs are staked out,—about one hundred feet apart this time,—and in the following winter they are sunk, prospected the next summer, and mapped."

The Wellington Series Engine.

We can do little more than simply call attention to the description of this invention presented in the *Engineering News* (April 8), which occupies nearly three pages of that journal. It will be remembered that, in the announcement of the death of the late A. M. Wellington in the spring of 1895 (at the time of his death editor of the journal quoted), mention was made of a remarkable invention upon which he was engaged, and upon which he had expended a very large amount of experimental work, which work was continued almost to the very last week of his useful and honored life. Whatever may be the outcome of this work in its influence upon the progress of mechanical engineering, it is without doubt one of the most interesting studies relating to heat engines conducted in recent years. Since each element of this system of engines consists of a boiler or vapor generator, engine, surface condenser, and means for re-

storing the liquid of condensation to the boiler, the novelties in the mechanical part of the system are in the line of construction, such as details of the boiler, means for effecting rapid circulation of liquids and vapors over the heating surfaces, etc. It is not new to use liquids volatilizing at a temperature lower than water for obtaining a vapor under working pressure by absorption of heat from the vapor of water at less than atmospheric pressure. In this way vapors at pressures higher than that of the atmosphere may be generated by water vapor whose pressure is lower than that of the atmosphere. The records of the American patent office will show a number of inventions directed to this purpose. For reasons upon which we shall not here enter, none of these inventions have come into general practical use. We shall not attempt to do more than give a general idea of the principles on which Mr. Wellington's invention rests. A heater delivers a liquid at 500 degrees to the boiler or vapor-generator of an engine wherein vapor under a working pressure is produced by extracting heat from the primary liquid and imparting it to another liquid which evaporates at lower temperature than that of the primary liquid, and wherein the primary liquid is cooled down to, say, 444 degrees; the primary liquid then passes along to another generator in the series, which generates vapor under less temperature and tension than that of the primary liquid, and wherein the latter is cooled down to, say, 388 degrees; and so on to the different generators of the series of engines, say, five in all, the temperature of the primary heating liquid being reduced in the last generator down to 220 degrees,—a mean reduction of 56 degrees for each vapor-generator. In passing through these generators, the heating liquid, going outward from the heater, imparts heat successively to the contents of each generator. The vapor produced in each generator of the series acts upon the piston of an engine, then passes over into one of a series of condensers, and is there condensed by the returning current of the same primary liquid going back to the heater. For, after having passed through the fifth or last generator, the circulating primary liquid flows through a surface-cooler, whereby its temperature is reduced from 220 degrees—the temperature at which it leaves the last generator—to 50 degrees, at which temperature it flows into the condenser of the fifth engine. Here it collects heat from the exhaust, its temperature being raised from 50 degrees to 97.6 degrees. Thence it passes into the condenser of the fourth engine of the series, where, in condensing the exhaust of that engine, its own temperature is raised to 145.2 degrees; so on through the condensers of the third, second, and first engines, arriving at the first condenser with a temperature of 240.4 degrees, and leaving it at a temperature of 288 degrees. Thence it passes again into the heater to regain a temperature increment by which it attains the original temperature of 500 degrees, completing the circuit. On its outer course from the heater to the cooler, the primary liquid gives off heat successively to the contents of each generator, which heat is successively converted into work by each of the serial engines; on its return from the cooler to the heater it takes up a portion of heat successively from each condenser. As it goes out, it is always hotter than the contents of the generator through which it passes; in the cooler its temperature is so reduced after passing through the last generator that thereafter it is always cooler than the contents of the condenser through which it passes, until it gets back again to the heater. The liquid of condensation is pumped back from each condenser to the generator whence it came, and the circulation of the primary liquid to and from the heater and cooler is also maintained by pumping. Suppose the primary liquid to be water, and the secondary liquid vaporized in the generator working the engine and condensed to liquid again in the condenser to be water, carbon disulphid, anhydrous ammonia, or other material capable of producing vapor or steam of working tension at a temperature lower than that corresponding to the same pressure of the primary liquid; it will then be easy to see

that such a system would be able to supply power so long as the primary heater and final cooler should maintain the stated difference of temperature. It can also be calculated that a much larger percentage of the heat imparted to the primary liquid (assuming that the theoretical temperatures could be maintained) would be converted into work than could be so converted by directly using the vapor of water in either a single or multiple-cylinder expanding engine; but, in so complicated a system of heat exchanges, it is too much to expect that the theoretical temperatures can be reached and maintained. There will be losses which, in the absence of actual experiment, cannot be estimated. The cycle can be proved to conform to the law of the Carnot cycle, the indicated power being a function of the difference between the high and low temperatures of the primary liquid. The mechanical features of the invention are interesting, the principal innovation being in the structure of the generators for producing vapor through the action of heat derived from the primary liquid, etc. The fact that heat is transferred very much more rapidly by a heated liquid on one side of a metallic septum to a cooler liquid on the opposite side than by a heated gaseous medium through a similar septum to a cooler liquid on the opposite side enables a very much smaller amount of surface to be used for the transmission of heat than is used with the ordinary steam boiler. We cannot here go into the details of this construction, but the extent of the innovation is indicated in the statement of our contemporary that "a boiler has actually been built and worked which generated forty h. p. with a weight and bulk only one two-hundreth as great as the ordinary stationary boiler of that power." It is added that, shortly after this boiler was finished, "Mr. Wellington hit upon an entirely new plan of boiler-construction, by which he hoped to go even farther in the direction above noted in the reduction of weight and bulk for a given power, and at the same time to make a boiler which could be constructed at a far less cost than the tubular boiler." All who knew Mr. Wellington, particularly his associate members of the American Society of Civil Engineers, will deeply regret that he did not live to advance further this his favorite study of improvement in heat engines.

Alternating-Current Dynamos in Parallel.

THE disadvantages of the prevailing system of running each machine on a separate circuit are set forth in the first part of a serial paper by J. E. Woodbridge in the *Electrical Engineer* (April 28). "The number of circuits increases necessarily with the number of machines, and the problem of properly distributing the loads on those circuits, so that in the evening each generator shall do its full share of the work, and yet not be overloaded by some unanticipated addition, is a serious one. A compromise which results in poor economy always has to be made with loads which are subject to sudden changes that cannot be foreseen in the central station, such as the theatre and church loads, etc. Then constant attendance is necesssary, as the load rises and falls through its daily range, to start up the fresh dynamos as they are needed, and switch on to them the different lines; and again, when the load falls off, to properly bunch the lines on certain dynamos, so as to keep the machines which are running always as near to their most efficient loads as possible. No little ingenuity is needed when the dynamos in the house are of various sizes and capacities. When the conditions are further complicated by the necessity of giving the longer feeders a higher voltage than the shorter ones, the increase in that voltage being proportioned roughly to the load, the switchboard man has no easy job. Added to that is the necessity of carrying over his circuits as nearly instantaneously as possible to prevent too long 'wink' in the lights; and the risk of accidentally throwing two machines in multiple by a mistake in the manipulation of his switches." A serious objection to independent alternators is this winking of lights, and it is spoken of as being one of the things favoring the introduction of the Welsbach gas-burner, whose comparative steadiness is one of its

chief recommendations. Mr. Woodbridge goes on to show that all the disadvantages which he has comprehensively enumerated are completely removed by "running all the alternators in a station in multiple on one set of bus-bars, from which all the feeders are tapped off, either direct or, in the case of long feeders, through adjustable boosting converters." He proceeds to show how the number of feeders can be thus much reduced and economy increased. For instance, "two No. 0000 lines cost less and give less trouble than the same amount of copper in eight No. 3 lines." He quotes the well-known experiment of Mr. Mordey as evidence of the entire possibility, as well as the commercial practicability, of running alternating-current dynamos in this way. The dynamos thus run will synchronize in speed, and will adjust the relations of voltage and phase (at least with the Mordey-Brush dynamos), running multiple under even more trying conditions than direct-current machines. The multiple method has been largely adopted in Europe, but has not been generally used in the United States. The large plant at Niagara is arranged to work in this way. This series of articles by Mr. Woodbridge shows that the idea that alternating dynamos must be specially made for multiple working is not broadly true, as most good machines of the same frequency will hold up to speed under a complete range of loads without excessive current, and will run synchronously.

Electric Lighting of the Armory of the Ninth Regiment N. G. S. N. Y.

THE lighting of this new old building, situated on the north side of Fourteenth street, New York city, between Sixth and Seventh avenues, and having a frontage of about 212 feet and a depth of 250 feet, presents some features worthy of notice. *The Electrical World* (April 3) gives considerable space to the illustration and description of the lighting installation, from which the following particulars are derived. There are 2,500 16 c.p. incandescent lamps in the various administration rooms, and 60 1,200-c.p. open-air Ajax arc lamps are employed for the illumination of the main hall. The arrangement of the arc lamps for the main hall is specially commended. "All the various fixtures, both for arc and incandescent purposes, are specially designed of wrought iron, and those in the main hall are also equipped with electrically-lighted gas-burners. Particularly in the main hall are two large clusters, each including twelve arc lamps, which are arranged in the form of a large chandelier centrally suspended from the center of the arches over the drill floor. The lamps, when raised, are about twenty-eight feet above the floor line." Ten single arc-lamp fixtures are arranged under each of two main balconies, these balconies being about sixteen feet above the floor. Over each end of the balcony are four single arc-lamp fixtures, twenty-one feet above the gallery floor. The lower part of each main fixture is a structure of metal work supporting a group of twelve arc lamps, each lamp suspended from an iron hook. The system appears to be an extension of that used in some of the buildings at the Chicago World's Fair, where arc lamps arranged in clusters, or "arkoliers," were used with great success. For lighting large spaces, this system presents some advantages. The "use of enclosed arcs also adds a number of features tending to increase the value of such methods. Lately, however, a number of very large halls have been thus illuminated with excellent results."

Eccentric Gearing.

MR. FRANK RICHARDS, in *American Machinist* (April 22), points out that this class of gearing has a merit not ordinarily attributed to it, the "quick return" movement being all that is generally thought of in connection with it; whereas, upon crank-actuated machines, the approximate uniformity of advance during the working stroke is, perhaps, of as great importance as the quick return. He exemplifies this by an eccentric gear diagram. Thus the planer can be run all the time at the best speed possible, which is, of course, with a well-designed machine, what the tool will stand for the whole stroke.

THE BRITISH PRESS

Architecture and Handicraft.

CITING two ancient authorities, Vitruvius and Pythius, Mr. T. C. Jackson, R. A., in a paper read before the Architectural Association in April (reported in *The Architect and Contract Reporter*, April 9), quotes both, and criticises both as to the importance of a knowledge of the handicrafts employed in building. Though Vitruvius is no longer in fashion as an architectural authority, the following opinion, expressed by that once vastly popular writer, serves as a text for Mr. Jackson's paper. "Architects who are mere handicraftsmen without literary training are unable to give a reason for what they do, while those who trust only to theory and book-learning without practical training seem to grasp at a shadow. . . . An architect must be properly trained in both fields. He must be both ingenious and teachable, for neither will wit without training nor training without wit make the perfect artist. He must be a skilful draughtsman, a learned geometrician, not ignorant of optics, instructed in arithmetic, a good historian, and a diligent student of philosophy. He must understand music, he must know something of medicine, he must be familiar with the decisions of the lawyers, he must understand astrology and astronomy." At one time all this would have been accepted as gospel. It shows the mutability of human standards that a writer of the present day may with impunity characterize it as "nonsense." While, in the same way that the knowledge of many of the things named benefits any one, they may benefit an architect, they are not essential to his success as an architect, any more than they would be to a navigator or the general of an army. The enumeration is a queer mixture of essentials with non-essentials, and its sweeping character is much modified by Vitruvius in his category of the uses which the knowledge named can be made to subserve in the practice of the architectural profession. Even this enumeration is much narrower than that given by Pythius, who, in the opinion of Vitruvius, goes much too far. Vitruvius admits that "it is only now and then that a man can excel in one art, even if he pursues no other. He has done quite enough in these several branches of study who has a fair knowledge of those parts and theories of them which are necessary to architecture." In other words, this all simmers down to the obvious truism that an architect needs to know the essentials of his art. But what are these essentials? Mr. Jackson asserts "that of late years there has been a revulsion against what he styles the Roman method of practising architecture, in favor of the Greek method. Many . . . have been preaching against the strictly professional view, and urging that a man cannot be expected to produce good designs who seldom or never comes into contact with the materials of which his design is to be constructed. We have argued that it is from the handling of material that suggestions in design can most readily be gathered; that reading about processes in building, or any of the arts that go to make up a building, will never teach a man to make the most of his opportunity . . . and how to design in accordance with the natural qualities of the material with which he has to deal." Mr. Jackson points out that these proposals, though they may seem revolutionary to the advocates of the established professional system, would, if adopted, still be far from bringing us again to the methods of the architects of four hundred or five hundred years ago. He avers that the contracts of the earlier period bound architects much more rigidly to a constant and intimate association with their work than modern architects would submit to. "The architect bound himself to come with his family and live in the place where he was to build; to engage workmen, and see that they did all that was necessary to be done; to work with his own hands, both in building and in sculpturing, as befitted a good sculptor and a master of the art of stone-cutting." A part of his duties was to visit the quarries and superintend the

quarrying of the stone; and he was restricted from undertaking any other work for the term of years covered by the contract without special permission of his employers, which, if granted, specified the exact amount of time he could employ upon such work. He was the "chief master-builder and superintendent of all the laborers, builders, master-workmen, and handicraftsmen employed on the building," and supplied the necessary dimensions, orders, and methods. Instead of being paid a commission, he was paid a salary for the term of service, with sometimes some added perquisites. The multitudinous details of the modern architect's office-business were unknown to the medieval architect. Personal interviews with employers on the spot where his work was in progress rendered much letter-writing needless, and he could concentrate his uninterrupted attention upon the single job in hand. Long and tedious hours grudgingly given to railway journeys were unknown to him. The power to change anything during the progress of the work was constantly at his command. While this state of things cannot be reëstablished in a hurry, or even at all, Mr. Jackson implies that it is a good thing to recall it, and he believes the modern architect may, if he will make the effort, get more into touch with the handicrafts, and that the practice of the art would benefit by the effort. On this line he completes an interesting paper with practical suggestions.

Connection of the Black Sea with the Baltic Sea.

ACCORDING to *The Engineer* (April 9), the scheme of connecting these two seas by a canal of capacity sufficient to permit the passage of the Russian war-ships, under plans and specifications prepared three years ago, which scheme was postponed on account of the death of the czar, has again come up for consideration. There is an unmistakable purpose to construct this canal, of which we condense a description from the contemporary named. The route proposed is from the Gulf of Riga along the rivers Duna, Beresina, and Dnieper, to Khershun in the Black sea. The length of the course is 994 miles. The canal will consist, when completed, of the deepened channels of the rivers named and new cuttings to make a continuous water-way having a draft of 28 feet. The estimated cost will be £20,000,000. It is estimated that five years will be necessary to complete the construction. The object of the canal is to connect the dockyards at Libau in the north with those at Nikolaieff in the south, so that war-vessels can be moved in a short time from one point to the other. As a collateral advantage, it is expected that a rich tract of country will be developed along the line of the canal, and that the water-way will become important as one of the great avenues of commerce. The region through which the canal will pass, and which is watered by the tributaries of the rivers named, is said to be fertile, and there are also mineral lands which will contribute to the traffic, the bulk of which will be in corn, timber, iron, salt, and hemp. Reference to any good map of the country will show that the Duna, or West Dwina, empties into the Gulf of Riga at Dunamunde, and is navigable to Velig, 400 miles from the mouth. The total length of the river is 650 miles, and its drainage area 28,350 square miles. At its mouth it is about a half a mile wide. At about 90 miles from the mouth the river has risen 280 feet above sea-level, and at the summit 511 feet. The channel is shallow and much obstructed by sand beds and rocks, and it is difficult of navigation, except during the autumn and spring floods. It is generally clothed in ice from November to April. The Beresinski canal, constructed in the latter part of the eighteenth century, connects the summit level of the Duna with the river Beresina. Traversing a portion of the river Ulla and the lakes Beloje and Beresina and the river Sevgatcha, connection is made with the Dnieper at an elevation of 385 feet above sea-level. The Dnieper, in the length of 1,000 miles, drains an area of 204,000 square miles. Fifty miles below its source it is 200 feet wide. Four hundred miles from the out-fall its width is 1,500 feet. It discharges into the Black sea through nine mouths, and the deepest water in any of

the channels does not exceed 10 feet. It is clothed in ice from January to March. It is expected that the greatest difficulties in the construction of the canal will be met in the upper part of the Dnieper, which passes through marshy and wooded country. The strategic advantages of the canal for naval purposes will be supplemented by the commercial advantages in the transport of produce from, and the development of, a rich agricultural and mineral country.

American Trans-Atlantic Telegraphy.

THE affairs of the American Commercial Cable Company, its present status, and the nature of its service, form the burden of an interesting article in *Engineering* (April 2). The origin of this line is referred to the need of obtaining cheap and abundant telegraphic matter from London every night for publication in the *New York Herald* on the following day. The proprietor of this paper, Mr. James Gordon Bennett, enlisted the coöperation of Mr. Mackay of San Francisco, and established the line, which immediately entered into competition for general telegraph business between the two continents. The enterprise has now acquired the property of the Postal Telegraph Cable Company. "The Anglo-American Telegraph Company, Limited, thought it had made a good stroke when it established intimate relations with the Western Union Telegraph Company, and the latter has been buying up competitors of all kinds for the last thirty years. It is a fruitless task, however, to endeavor to extinguish American competition, as no sooner is one company absorbed than another presents itself. The capital stock of the Commercial Cable Company stood, at the close of 1896, at $10,000,000, and the dividends for 1893, 1894, and 1895 amounted to $700,000 in each year, while for 1896 they rose to $800,000. In other words, the proprietors received last year a return upon their capital at the rate of 8 per cent. per annum. The net revenue of the company amounted in 1893 to $1,057,747, in 1894 to $1,010,438, in 1895 to $1,215,308, and in 1896 to $1,176,565. The increase in the amount distributed in dividends last year was due to the declaration of a bonus of one per cent. in addition to four quarterly dividends of 1.75 per cent. per annum. After paying these dividends, the company was able to carry forward a balance of undivided profit of $846,678. The reserve fund was also increased last year to the extent of $250,000." The reserve-fund account had a credit at the end of the year of $2,041,821. The revenue of the company increased during the year $9,518, but the working expenses increased $48,350. The increase in working expenses is attributed to extensive repairs carried out during the year. From these facts it is inferred that the affairs of the company are in good working condition, and that it has certainly become one of the permanent lines between the two continents. At the same time *Engineering* regards it as doubtful whether English investors will take kindly to the Commercial Cable Company. It concedes, however, that it is the "most persevering and carefully-administered American Atlantic telegraph company with which the Anglo-American Telegraph Company has ever had to contend. . . . The English Company crossed swords in its day with the redoubtable Jay Gould, but he was soon bought up. The Paris and New York Telegraph Company had also not been a particularly serious opponent, but the Commercial Cable Company is a different kind of an affair altogether." At the same time, it is claimed that the affairs of the Anglo-American Company are slowly improving, although there is much yet to be desired. The Commercial Cable Company has a capital of less than one-third that of the Anglo-American Company, but earns nearly as large an annual profit as the latter. Hope is expressed that the future of the Anglo-American Company will be improved by the gradual increase of telegraphic business. While the Commercial Cable Company has built up a good business, the Anglo-American Company has also been picking up, rather than losing, for the last three or four years. This indicates a vital tendency toward increase in telegraphic communica-

tion between the continents. It is regarded as all the more significant that it has occurred during a period of great financial depression in the United States. It is therefore argued that transatlantic telegraphy is destined to become more remunerative as time elapses. The affairs of the Commercial Cable Company display admirable management, and its prosperity will be a source of pride to the American people.

Increased Consumption of Coal Gas.

IT was at one time believed that the manufacture of coal gas was likely to be greatly injured as an industry by the introduction and extension of electric lighting. It is probable, however, that, if statistics of production were consulted, the industry would be found to have increased considerably. It is likely that the amount of gas used per head for lighting, inclusive of street-lighting, is less than it was twenty-five years ago, but the populations of countries wherein gas is used as an illuminant have considerably increased, and during this period the uses of gas for warming apartments, cooking food, and for power, have come to be extensive, and are each year increasing. In a serial by Thomas Fletcher, begun in *The Gas World* (April 3), the commercial uses of coal gas are stated, and many interesting facts connected therewith are set forth. Among these the extension of the use of gas for industrial purposes other than light and power is one of the most interesting. Thus gas is used, among other things, for press heating, calender rolls, branding machines, boot-finishers' and book-binders' tool heating, bakers' ovens, in the wire trade, wire-cable-making, and in welding lead sheets in the manufacture of acid chambers and lead cisterns. It is also used to supply heat for melting solder in soldering machines, and for other purposes. These uses appear, on the whole, to have more than compensated for the competition with electric lighting, so that the gas industry need no longer fear such competition, unless, as seems improbable, very much cheaper methods of generating the electric light shall be discovered.

Salt Water in Water-Tube Boilers.

FOR a long time after the introduction of water-tube boilers, it was held to be almost axiomatic that they could be used with fresh water only. The evils of priming, salting, and even of plugging the tubes with salt, were assumed as certain to accompany the use of sea-water in a boiler of this type. It is to be confessed that such an inference was based upon good grounds, and that confirmatory proof has not been lacking. *The Engineer* (London, March 12) editorially discusses and describes some experiments carried out by Messrs. Yarrow & Co. to determine whether, in spite of the general opinion, the use of sea-water temporarily in such boilers, in cases of emergency, would be practicable. The first experiment dates back to 1888 or 1889, with the original experimental water-tube boiler made by the firm named. This boiler "is a small generator, with two separate steam drums and two lower chambers." It was set up in the yard of the works, and supplied with clean sea-water brought by railway from the coast for the purpose, and steam was generated at atmospheric pressure. A continuous run of forty hours was made. During the run the boiler did not prime, but about two dozen of the tubes (one inch in diameter and four feet long) "were salted up solid." There was no scumming or blowing off of the water. "The tubes being straight, it is comparatively easy to drill the salt out with a species of augur or twist drill, made for the purpose. We have seen," says *The Engineer*, "a tube thus cleaned in a very short time; and, so far as we could see from careful inspection, if the tubes were thus cleaned, the boiler would be ready for service." With all respect for the opinion of our esteemed contemporary, we submit that, after such an occurrence in a tubulous boiler, nothing short of a hydraulic test could prove that it had passed uninjured through the trial. In another place it is tacitly admitted that there was bending and distortion of the tubes; this would at once, in our opinion, indicate that, however well the boiler looked in other respects, it would be apt to leak under pressure. Neither is it ap-

parent from this experiment that, had this been "a real torpedo-boat boiler, such a boat could have steamed four hundred miles at ten miles an hour," on salt-water feed, as asserted in the article reviewed. Only an experiment with salt-water-supply under precisely the practical conditions of marine propulsion could determine the practicability of using salt-water feed for even a temporary service. Such a test, recently made by the same firm, is conclusive as regards short runs, with a torpedo boat, since it lasted four hours and fifteen minutes. What would have happened had the run been extended to forty hours cannot, in the absence of such a run, be predicted. What did happen was that, when salt water was first fed to the boilers, there was some priming. The boiler pressure being maintained at two hundred pounds, and the steam being wire-drawn to one hundred and fifty pounds, comparatively dry steam was obtained, and the water remained more steady in the boiler. Under these conditions a speed of about seventeen knots, with 250 h. p. developed, was attained, according to estimate, though no diagrams were taken. Our cotemporary states that this is but one of several runs made with salt-water feed by this boat, with examination of the boiler after each run. "Instead of the heating surfaces being heavily coated with lime salt adhering, they are coated with a loose deposit crumbling away under the fingers and readily brushed off from the surfaces. There is some reason to think that at high pressure the lime salt, instead of adhering, like cement, to the metal, comes down as a non-adherent powder, which can be easily washed out." We should not like to accept this view without further experimental evidence. Neither would we be able to accept the opinion that, with proper blowing-off and scumming (purposely omitted in the short trials), a Yarrow boiler could be "run for a month without trouble." This can be proved only by a month's successful run on salt-water feed. Theory and personal judgment alone cannot be relied upon in a matter of this sort, where so many unknown quantities may become factors.

Efficiency in the Arc Light.

THIS subject is discussed in a paper by Thomas Hesketh (*The Electrician*, April 9), in which he reduces the factors governing the quantity of light as related to the energy consumed in producing it, roughly, into two,—to wit, the diameters of the carbon and the length of the arc. He states that the rule which has been formulated from the experiments of Herr Schreihage errs on the side of underestimation, in that it makes the light of the arc vary in inverse proportion to the carbon diameters. "Tests taken by M. Jean Rey with a 20-ampere direct-current lamp, with two pairs of carbons 21 mm. and 13 mm., and 14 mm. and 8 mm., respectively, resulted in no less than *three times* the volume of light from the smaller pair for the same electrical energy. These results, together with the lesson they teach, are not difficult to realize, when one considers the point from which the emission of light takes place. The first and most obvious improvement is to be produced by the reduction of the negative carbon to the smallest possible extent. By this means the crater of the positive, which is the actual source of light, is less shielded, and more rays are free to escape. This enhancement has already been effected in the majority of our better lamps, but not to so great an extent as the case warrants and demands. It must not be imagined, however, that the increased efficiency resulting from the reduction of the carbon diameters is due to this cause alone." Mr. Hesketh points out that the main effect is due to confining the heat of the arc to the smaller body of carbon. There is also a reduction of heat loss through conduction and radiation. For these reasons, the author maintains, "the lamp of the future must burn smaller carbons." There are, however, limits to this rule which he does not overlook. One of these is "the increased length of rod consumed for the reduction in its diameters; but, if our station engineers would consider the amount of light gained, and not be wholly influenced by the lamp-trimmers' wages, we should soon have our street-lamps burning with half their

present size of carbon. In some parts of the continent lamps are nightly in use with a 20-ampere arc perfectly maintained between carbons of 12 mm. and 10 mm. diameter." Surprise is expressed at the cost of the light thrown away in England by the use of the larger carbons, in comparison with the slight increase in wages necessary in order to trim and carbon lamps with carbons of smaller diameter. Mr. Hesketh thinks that the advantages secured in the distribution of light from a long arc can well be left out of consideration, until the full advantages of reducing the diameters of the carbon have been realized.

Casting Direct from the Blast Furnace.

THE possibility of casting direct from the blast furnace has often been considered, and to some extent discussed. The fact that this system has never been generally adopted shows, however, that the idea has not been very far advanced. Mr. W. H. Butlin, in *The Iron & Coal Trade's Review* (April 2), takes up the subject again, and argues, not only from general principles, but from his own experience, the practicability of this method. To the article (which is one of considerable length) the editor of the journal quoted appends a note, stating that Mr. Butlin accompanied the article with specimens of the castings which he refers to, which were placed on view at its offices. Mr. Butlin says that hitherto the drawbacks to this system have been considered too great to permit of its direct application. The intervention of the cupola has been considered necessary, on account of the variable quality of the metal, except for the more important uses. He believes, however, that this is an erroneous conclusion, and asserts that, with careful scientific treatment, he has been able for a long time past to produce good, sound, soft castings, uniform in quality and capable of standing the test of the hardest wear possible about an ironworks. These castings have been successfully used in tip-wagon, furnace, barrel and bogie wheels, valve seatings, and other engineering works. The results are due to scientific mixtures and a chemical knowledge of the materials employed. "Iron is iron, but it may be largely influenced by the foreign substances alloyed with it in the form designated cast-iron. The salient characteristics of the metaloids associated with it must largely determine its quality according to their preponderance, but, in the writer's opinion, we may, chiefly for the purposes of investigation, ordinarily limit these to three,—*i. e.*, oxygen, carbon, and silicon. Oxygen is present from the oxids, principally of the ores smelted, and is also contained in the air or blast; carbon is present from the fuel or the carbonates either of the ore or limestone; silicon is present from the silica of the ores, etc. We may perhaps neglect the influence of manganese in Northampton ores, as usually the amount present is only a fraction of one per cent." Mr. Butlin quotes Mr. Robert Mushet in support of the opinion that all iron which has been too much oxidized in smelting can be restored by treating it with carbon. At least, Mr. Mushet so regarded the "overblow" in the converter steel process. "In the blast furnace there is, of course, always the preponderating influence in a reducing atmosphere of the carbon oxid modifying the oxygen effect; but here it will be well to notice that temperature plays an important part. Carbon, I think, most readily combines with iron at comparatively low temperatures, as often noticed in the cooling effect of scrap added to a hot furnace when promoting grey iron and abundance of graphite. Silicon seems to have baneful effects at high temperatures." From these facts Mr. Butlin assumes the hypothesis that carbon at a low temperature, and silicon at a high temperature, have greatest influence upon the character of the metal. "We know that, when a certain amount of silicon is present, grey iron is made more readily (*ceteris paribus*), but I think we need to have the required silicon present at low temperatures relatively, that carbon may exert its greatest influence and deposit graphite in the pig metal." Fusibility must be studied, and the most fusible slags are those of the more acid type. Foundry iron produced from these will be considerable in quantity, if low temperatures are used, consistent with their acid type. To

obtain the requisite fluidity in accordance with chemical composition and temperature requires experience, based upon knowledge of the materials employed. Mr. Butlin thinks these are worth working for, and he states that they are "surprising to the novice when viewed beside a miscellaneous use of the same materials unaided by the scientific method." His views with reference to temperatures are radical. "I hope that I may not be accused of a too daring hypothesis in expressing an opinion favorable to the employment of temperatures within the range of pipe stoves as aiding quality," with "ores suitable to the formation of the more acid type of slags. Why treat tender, friable, and fusible ores with the greatest temperatures attainable? —no doubt, with a certain dubious economy; but such a method cannot be understood, much less appreciated, unless the object aimed at be mere quantity at the entire expense of quality." It is maintained that the greatest quantitative yield with good quality and uniformity cannot be attained by excessively high temperatures. The concluding portions of the paper give further reasons for this view, for which the article itself must be consulted.

Coal Production and Consumption in Different Countries.

SOME very interesting facts and statistics are given editorially in *Engineering* (March 26). These are prefaced by the remarks that the use of coal *per capita* is an erroneous basis on which to estimate the advancement of civilization in a particular country. For instance, in Russia, much wood and oil are used as fuel for mechanical and manufacturing purposes; and similar influences affect more or less the consumption in the United States. In the United Kingdom the average consumption is 3.75 tons of coal per annum for each individual. In Russia it is only 0.1 ton per annum per individual. In the United States it is about 2.44 tons. In Sweden something less than 0.5 ton. Belgium consumes per individual 2.66 tons per annum; Germany 1.38 tons; France 0.95; and Austria-Hungary 0.33 tons per individual. Spain and Italy consume per individual something more than Russia, the quantity being for Spain 0.19, and for Italy 0.15 ton. The conditions of consumption are stable from year to year, but improved practice in steam engineering affects the result more or less in countries wherein steam is largely used. Attention is called to the fact that in England, although coal is cheaper than in most countries, a constant effort for greater efficiency in its consumption is made. The growing practice of using gas in the kitchens of private dwellings for cooking purposes is reducing the consumption of coal in both England and the United States, the intermittent use of gas enabling it to be economized more than coal can be. The increase of consumption in England *per capita* is stated to have been about 2 cwt. in twelve years. At the same time there has been a considerable extension of mechanical power during the period. Germany has increased her consumption in the same time 0.32 ton *per capita*, and it is thought that this is mainly due to the increased iron production. Belgium has increased its annual consumption in the twelve years 0.11 ton *per capita*, France 0.14 ton, Russia 0.04 ton. Japan has increased its annual consumption 0.04 ton *per capita* in the same time, its present annual consumption being 0.06 ton. A marked advance has taken place in the United States, which has increased its consumption in the time named by 0.53 ton per individual. This is accounted for by greater iron production, increased use of mechanical power, and the falling off of the output of natural gas, which for some years has been largely used as a substitute for coal. The total increase of consumption in the United States per annum has been 68,000,000 tons in the period named, which represents in power a production of 1,700,000 i.h.p. It might also be estimated in increase of production of tons of iron, and would in that way represent from 70 to 75 million tons. The point is made that the United States now use more coal than is used in the United Kingdom, the annual consumption in England being 146,750,000 tons. The increase

in Germany during the period named has been 23,000,000 tons. Whereas, twelve years ago, England burned three tons of coal where Germany burned one, Germany now uses two tons for every three used in England. The increase in England has been only 12,000,000 tons during the period under consideration, but it is claimed that this does not by any means represent the advance in England, which has rather been in the line of efficiency than in the quantity consumed, The consumption in all Europe exceeds that in the United Kingdom by about 15,000,000 tons. "Consumption is, however, not to be confused with production, and here England still excels even the United States, although it must be confessed that they are moving steadily forward to first position . . . . They have not, however, entered in any seriousness upon the export trade (their shipments are 2.5 million tons), but in this fact there is not much satisfaction for us. It would be better for us if we could utilize still more of our coal, rather than send such a surplus as 43,000,000 tons to other countries. What we want to export is manufactures, not raw material. Of course, much of this coal goes to our colonies; but over 18,000,000 tons goes to Europe, a large part probably to support competitive manufactories." Germany has increased her production in twelve years from 55,940,000 tons to 79,160,000; Belgium has increased her output from 18,100,000 tons to 20,400,000; France has increased her output 7,000,000 tons, but she still has to import 9,000,000 tons. Her increased output is almost entirely absorbed at home. In Russia the greater part of this increase in consumption is the product of Russian mines, the output having risen nearly 4,500,000 tons during the period, while the imports have remained almost stationary. The British colonies, with the exception of New South Wales, use about half a ton of coal *per capita* per annum, but they import a large proportion of this consumption. New South Wales, while using nearly as much as all the other colonies put together, exports more than 2,000,000 tons. India imports about 700,000 tons and uses about 3,500,000, so that she produces nearly 3,000,000 tons. There has not, however, been any improvement in consumption *per capita* in India, the consumption having simply kept pace with the increase in population. As to cost of production, the latest returns in the United States show that 4s. 6d. gets a ton of coal in the United States, while in England 6s. 0.5d. is required. From this fact, the possibility that the United States will largely increase its exports of coal is inferred. Its effect also in increasing mechanical power and cheapening manufacture is noted. The cost of producing coal in Germany has recently been about 6s. 9.75d. In Belgium the cost of coal is 7s. 6.75d.; in France, 8s. 10d.; in Hungary, 8s. 9.5d.; in New South Wales, 5s. 10d., and in other colonies it varies from 8s. 2d. to 12s. 2d. Notwithstanding the fact that in England the cost of coal-getting is greater than it is in the United States, England exports most of the foreign coal purchased in European markets. The less cost of getting coal in the United States is attributed to the greater use of coal-getting machinery.

Architects as Interior Decorators.

A PAPER read by Mr. T. Butler Wilson before the Leeds and Yorkshire Architectural Society (*Architect and Contract Reporter*, London, April 9) urges that interior decoration and furnishing should be brought under the control of the architect who designs a structure requiring such decoration. He says that, as regards this matter, "the architect stands aloof in silence,—anything but a dignified silence,—and allows the trade to deal with things which should be to him the most interesting and important duties of his profession." One reason for this state of affairs is found in the fact that "the public is not quite sure of the architect as a decorative artist. The few and notable members of the profession who have distinguished themselves in this branch of art are regarded as exceptions that prove the rule of general mediocrity."

THE FRENCH AND GERMAN PRESS

Electric Motors in Textile Industries.

THE application of independent electric motors for driving various machines is on the increase in various lines of the work, and is probably extending more rapidly in this country than in Europe. In the textile industry, however, independent electric-driving is found most convenient, and *La Revue Technique* for March 25 gives several examples of such driving, both in France and Switzerland.

In the well-known silk mills of Zurich and Rüti a number of looms are operated by independent motors with satisfactory results. The motors used are of the three-phase type, constructed by the Oerlikon works, each motor being placed on the floor directly beneath the pulley of the loom. The motor pulley is belted to the loom pulley, the motor being hung in a pivot frame, so that its weight gives the necessary tension to the belt, the whole being under the immediate control of the loom-tender. The controlling lever is arranged so as to stop the motor (in the manner in which the belt is shifted in the usual arrangement) if the loom should "knock off," thus preventing accidents to the fabric. In some cases each motor is used to drive several looms, the weaving room being fitted with short cross-shafts overhead, and each shaft having its own motor, the looms being belted from the shafts in the usual manner.

One of the most interesting of the changes which may be effected by the use of electrical transmission is seen at Saint-Etienne, where a company has been organized to distribute power to the houses of the ribbon-weavers. The ribbon industry employs a great number of workmen who have heretofore operated their own looms by manual labor at their homes, each house or apartment containing two or three looms. A single motor of ¼ h. p. is sufficient to operate three looms, and a large number have been introduced for this purpose. Already more than 1,200 looms are thus operated, and, the original power plant of 900 h. p. being entirely taken, a second installation of 1,000 h. p. is now being planned.

The social effect of this movement is worth considering, as it may be the manifestation of a powerful rival to the factory system, which otherwise bids fair in many localities to extinguish the individuality of the workman altogether. When the skilled workman is his own employer and the master of his own motive power, many of the labor problems which are the artificial creation of the factory system will find their own solution.

Freezing-Processes for Excavation.

LA REVUE TECHNIQUE for March 25 contains a *résumé* of the various processes for the utilization of freezing to enable excavations to be carried on in quicksands and water-bearing strata, and, although such processes are well known in America, the article is worthy of notice here.

Probably the earliest application of cold for this purpose was made in the Siberian mines, it having been employed there from time immemorial by the Samoyedes. The object there is to reach the gold-bearing rock, which is in many places beneath strata of gravel and sand containing watery seams, and the somewhat primitive method is to use the natural cold of the winter season. The ground is kept clear of snow, so as to permit the cold to penetrate as deeply as possible, after which the surface is thawed by fires until a shallow layer of earth can be removed. The freezing is then allowed to proceed, and the thawing operation repeated, and this is continued as long as the cold weather lasts. In this way, through the long Siberian winters, open excavations are made to the gold-bearing rocks, the depth attained being from twenty-five to seventy-five feet, according to the duration of the cold season.

Artificial cold for purposes of excavation was used first by Poetsch in 1883; by his well-known process of the circulation of cold brine through a series of buried pipes the most difficult quicksand

may be made hard enough to be excavated like rock. In the article under consideration are given general illustrations and details of the apparatus used in sinking the shaft at the Courrieres mines, together with formulas enabling the safe thickness of frozen wall to be computed for round or square shafts of any given dimensions.

Among the important applications of the freezing-process are noted the sinking of the shafts for the cylinders of the hydraulic elevator for the canal lift at Les Fontinettes, and the construction of a tunnel at Stockholm. The latter work was executed entirely by the introduction of cold air into the working-chamber at the head of the tunnel, the cold preventing the infiltration of water until the béton lining was built, and the work of excavating and lining being carried on at temperatures ranging between 0°, and 25° F.

Apparatus for Disinfection.

In the issue of the *Gesundheits-Ingenieur* for February 28 is given an illustrated description of the building and apparatus for the hospital for epidemics at Brünn.

Besides the use of steam for disinfecting clothing, the problems to be solved in the plant were as follows:

All the water from the baths and washing from the three pavilions of the hospital, as well as the condensed steam from the disinfecting chambers, were to be rendered harmless before being discharged into the drain-pipes, which led away to a gravelly tract, through which the water was to find its way to the river Schwarzawa. Also all the discharges from the patients were to be burned. To these necessary requirements it was also decided to add such features of construction as would enable the heat generated to be utilized for warming the pavilions and to supply the drying-room of the hospital laundry.

These results have been successfully accomplished with very simple means. The sterilization of the wash-water is performed in a horizontal tubular boiler, practically arranged as a hot-water-heating boiler, except that the circulating feature is omitted. The water from the pavilions passes into the boiler, where it is heated to a temperature of 212° to 230° F., and, after flowing through the heating pipes in the drying rooms and pavilions, is allowed to drain away to the river, thoroughly sterilized and harmless.

The boiler is provided with a peculiar setting, the furnace being placed in front, and constructed somewhat like a Siemens gas-producer, with steeply-inclined main grate and smaller horizontal grate at bottom. A deep bed of coal is maintained, thus furnishing a supply of gas which is delivered into a combustion chamber. Above the combustion chamber is a funnel of brickwork, into which the solid discharges which are to be consumed are fed, having first been mixed with peat. The arrangement of this funnel is such that all the matter is thoroughly dried under the action of a down draft, and, falling upon the lower part of the grate directly in the path of the fuel-gas, the dried mixture is very completely incinerated, the gases of combustion all passing through the tubes of the boiler and rendering up their heat to the water.

The entire apparatus, including the drying-room for the laundry, is placed in a building entirely separate from the hospital pavilions, and the washed garments are thoroughly disinfected in a Thursfield apparatus before being taken to the drying-room. The sanitary and engineering details of the entire installation appear to have been very carefully worked out, and the plant has been found entirely satisfactory in practice.

The Wiborgh Thermophone.

The Wiborgh Thermophone, about which some general information has already appeared, is very thoroughly discussed in the *Oesterr. Zeitschr. für Berg- u. Hüttenwesen*, for February 20, by Herr von Jüptner. The principle of the thermophone is that of the time required for a given amount of heat to penetrate to the center of a mass of fire-clay, graphite, or other resistant material. A small cylinder of, say, fire-clay has in its center a little pellet of a specially-prepared explosive,

which, when heated to a predetermined temperature, will explode with a characteristic report. If a number of these cylinders are made, all as nearly alike as possible, and exposed to different high temperatures, it is evident that the time which elapses between the exposure to the heat and the sound of the explosion may be considered as a function of the temperature.

Having determined upon a standard size and uniform material for the thermophones, Prof. Wiborgh has determined, partly from empirical data and partly by theoretical considerations, the relations existing between time and temperature, and computed very complete tables giving the time corresponding to every ten degrees of temperature. With these tables and a stock of thermophones, it is necessary only to throw one of the little cylinders into the space of which the temperature is to be measured and note the number of seconds which elapse before the report is heard, when the approximate temperature may be taken at once from the tables.

It is found, however, that the time varies somewhat, according to the character of the surroundings, being different, for instance, when the thermophone is exposed to flame, or when placed in contact with the surface of molten metal; hence three tables have been computed for use with varying conditions. For flues, heated gases, etc., the best method is to insert an iron tube, closed at the inner end, and, after the tube has attained the temperature of the gases, drop the thermophone in, and note the time before the explosion. A similar tube may be used for melted metals of moderate temperatures, while for metals of very high fusing-points the thermophone is thrown directly upon the surface, in each case using the corresponding table.

Judging from results given by Herr von Jüptner, the determination of temperatures by this means is not so precise as with the higher grates of pyrometers, such, for example, as the Le Chatelier instrument; but the simplicity of the thermophone, and the readiness with which it may be used anywhere for preliminary investigations, should make it a useful auxiliary to more accurate, but more complicated, apparatus.

The Kyffhaüser Monument.

We have referred in these columns to the disappointing character of the designs submitted for the Leipzig monument, and are glad to be able to express a different opinion of the noble design of the impressive Kyffhaüser monument, by Prof. Bruno Schmitz, of Berlin. The completed monument, as illustrated in the *Deutsche Bauzeitung* for February 27 and March 6, shows several modifications in the original design, and, judging from the reproductions of photographs, both of the entire monument and of various details, the work is most worthily conceived and admirably executed.

The fundamental idea of the monument —the fulfilment of the ancient prophecy of the return of the sleeping Barbarossa to restore the empire to Germany, in the person of the Emperor William I,—is emphasized by its erection upon the historic Kyffhaüser mountain, the traditionary rock within which still sleeps the Barbarossa of myth and legend; and both architect and sculptor have embodied the spirit of the story in the work.

The rugged stonework of the approach, composed, as it is, of blocks hewn from the mountain behind, makes an admirable introduction to the first view of Geiger's noble statue of the seated Barbarossa, and the dignified imperial figure strongly suggests the Moses of Michel Angelo, both in pose and expression. From the severe tower above, typical of the reconstructed empire as signified by the imperial crown which forms the summit, rides forth the founder of the new empire, the whole forming a realization in stone and bronze of history and legend, past and present.

European Warships.

In view of the present relations of the powers of Europe, the comparison of the naval strength of the various continental nations, as given in an article in *Stahl und Eisen* for April 1, is of interest. The article is accompanied by a fac-simile of the large chart prepared by the hand of the emperor of Germany, showing the comparatively meager preparations which Germany has made to increase her naval

strength, and intended, doubtless, to justify the appeal made to the reichstag for greatly-increased naval appropriations. The German navy has fallen behind in nearly all the departments, compared with the plans which had been made for its growth, and, if Germany is to maintain her position, something must be done to supply the deficiency; else the pretence of maintaining a first-class navy must be abandoned.

The following table shows clearly the status of the leading continental nations, and also the relative strength of the triple alliance of Germany, Austro-Hungary, and Italy as compared with the united strength of France and Russia.

	Battle Ships.	Coast Defence Vessels.	Armored Gunboats.	Armored and Protected Cruisers.	Despatch Boats.	Torpedo Catchers.	Torpedo Boats.	Unarmored Vessels.
Germany	11	8	13	14	10	10	89	24
Italy	12	5	—	19	15	8	138	22
Austro-Hungary	13	–	—	6	7	7	68	11
England	57	16	—	135	4[illegible]	90	101	50
France	26	14	8	44	19	13	239	36
Russia	19	14	14	17	—	14	179	29
France over Germany	15	6	—	30	9	3	150	12
France & Russia over Triple Alliance	9	15	9	22	—	7	123	8

Decimal Time.

THE question of the decimal subdivision of time is again being discussed in France, in view of the approaching session of the commission having the matter in charge. *Le Génie Moderne*, in its issue of April 1, gives a brief review of the discussion at the last conference. The subject was regarded from two points: should the day still be divided into 24 hours, and the decimal subdivision be applied only to the hour, or should the day be divided into 10 or 20 hours? It was the unanimous opinion of the commission that the 24-hour division of the day should be retained, but that the hour should be divided into 100 subdivisions, and these further divided into 100 parts, names for these new parts being yet to be devised; also that the hours should be counted continuously from 0 to 24. The present session is to be occupied principally with the centesimal division of the circle, and with the preparation of a definite report upon the whole subject. This will include suggestions as to the best methods of putting the proposed changes into effect in France, and probably the submission of the matter to an international conference.

It will be remembered that the decimal division of time was one of the reforms attempted by the National Convention at the time of the establishment of the revolutionary calendar in France, the decree of the Convention of 4 Frimaire, in the year II (November 24, 1793) having divided the day into 10 hours and the hour into 100 divisions and 10,000 subdivisions. The plan did not meet with success, as the popular sentiment in favor of the 24-hour division of the day was too strong to be overcome. Doubtless it was in deference to this historical fact that the present commission hesitated to imperil its work by similar opposition.

The centesimal division of the quadrant also failed of acceptance at that time, although very complete tables of angular functions and their logarithms were computed. These tables, which are still in manuscript, represent a vast amount of accurate work, and have frequently been consulted to assist in correcting errors and comparing results by computers of other nations; and, if the proposed change is attempted in France, it is not improbable that the "great French manuscript tables," as they are called, may be published.

The prospects of the general introduction of the proposed changes are, we think, decidedly remote, especially in view of the strong opposition of late developed in this country against the metric system itself. If the 24-hour division is retained, the general public will pay but little attento the subdivisions of the hour. It will be found that there are two opposing elements in human practice in subdivision; the decimal, based upon the ten fingers, and the idea of continual bisection, which is almost as strong, and quite as natural. The two can never be entirely reconciled, and it is not impossible that in the far distant future we shall wonder why people ever retained either.

Incandescent Gas-Burners.

A COMMUNICATION to the Belgian Association of Gas Manufacturers by M. A. Bandsept, printed in the *Moniteur Industriel* for March 6, gives the results of attempts to improve the performance of incandescent gas-burners of the Welsbach type by producing a more intimate mixture of the air and gas before combustion. It is well known that such mixing greatly increases the efficiency of gas engines, and, theoretically, the more intense heat thus produced should increase the quantity of light from a burner depending upon the heating power for its illuminating effect.

The burner described by M. Bandsept is constructed so that the air and gas in entering, pass through a system of orifices forming a kind of atomizer, the proportion of gas and air being capable of adjustment experimentally, until the best effect is produced. The heat which may be thus produced is much more intense than that of the common Bunsen burner, readily fusing fine platinum wire, or iron or copper of several millimeters in thickness. When the gas-pressure is high, the combustion of the mixed air and gas is accompanied by a humming noise, due to the rapid succession of minute explosions; but this should not occur at the pressure used for ordinary lighting. Exact figures of the actual economy effected by this form of construction are yet lacking, but there can be little doubt that the higher temperature thus obtainable from a given quantity of gas should have a corresponding effect upon the illuminating power.

Electrical Industry in Russia.

RUSSIA appears to be carrying out her traditional policy of stimulating the growth of internal industry, by developing the arts depending upon electricity; an account of the extent to which progress in this direction has been made is given in the issue of *Die Elektricität* for March 13. In order to encourage the development of electrical industries, liberal concessions have been made to foreign corporations, both for lighting and for tramways, while the installations thus operated are being made the subject of earnest study by Russian technologists. As a consequence, although most of the machinery for the original plants was imported from England, Germany, and Switzerland, the building of eiectrical machinery is now beginning at home. There are now three builders of dynamos in St. Petersburg, one in Riga, and one in Wiborg, besides several establishments constructing accumulators and conductors. As yet the great bulk of the incandescent lamps and carbons are imported from Germany, but the Russian copper industry has already adopted the use of electrolytic reduction, both at the mines in the Caucasus and at Nijni-Novgorod. The German manufacturers are making strenuous efforts to control the Russian electrical trade, and to retard the development of local establishments, but the Russian policy of forcing home development is as strong to-day as in the days of Nicholas I, and will doubtless be pursued, regardless of questions of immediate economy or expediency.

Survey of Madagascar.

THE conquest of Madagascar by the French is bearing fruit, so far as geographical science is concerned, and the interior of the island, hitherto almost an unknown country, may now be mapped with a high degree of precision.

At the session of the Académie des Sciences, reported in *Le Génie Moderne* of April 1, Col. Bassot placed upon record a communication from M. R. Bourgeois, the chief of the geographical expedition to Madagascar, giving the principal results of the triangulation made of the island by Captain Peyronnel under his direction. The system extends from Majunga to the peak of Andriba, and includes stations on forty-nine mountain summits, this geodesic system having also been connected by route-surveys with positions astronomically determined. The work has been connected with the hydrographic surveys previously made, so that the coast, which has been well known for some time, is now in geodesic relation with the interior of the island.

The Rathausen Electric Station.

THE traveler in Switzerland will remember the rapid current of the Reuss as it flows from the Lake of Lucerne. This unfailing stream is now utilized in a most successful power station at Rathausen, about four miles down the river. An excellent account of this, one of the most recent water-power installations in Switzerland, is given in the *Elektrotechnische Zeitschrift* for March 4, with numerous illustrations.

The available fall is about 15 feet, and the supply about 900 cubic feet per second, so that there is nearly 1,500 h. p. to be obtained by damming the stream. The present works were begun in November, 1894, and completed in June, 1896. They include a dam, with canal leading the water to the works,—a building with machinery,—and a tail race canal, each canal being about three-quarters of a mile long.

The power plant consists at present of three turbines of 300 h. p. each at 60 revolutions, together with a small 6-h. p. turbine, used to operate the regulating gates, while there are pits for two more wheels of 300 h. p. each, which, when installed, will enable the entire power of the Reuss to be utilized.

The generators are directly connected to the turbine shafts, the armatures being stationary and the fields revolving. Owing to the moderate speed of rotation, the revolving fields are of large diameter, 3.6 meters giving a velocity of 2,227 feet per minute. The alternating current of 3,300 volts is transmitted to Emmenweid, Kriens, and Lucerne, the voltage being reduced by transformers at Eichhof to 1,500 volts; the maximum distance to which the current is transmitted is 9.2 kilometers.

The general equipment and arrangement of the station are most attractive. The plant, so far as the electric portion is concerned, was constructed by Brown, Boveri & Co., of Baden, the turbines being those of Th. Bell & Co., of Kriens.

In view of what is being done in this country, the scale of charges for electric power in Switzerland are of interest. The rate is made per day of twelve hours, from 6 A. M. to 7 P. M., on the following scale:

1 h. p.	$70.00 per year.
10 "	51.40 " "
50 "	36.00 " "
100 "	30.00 " "

At these prices an output of 983 h. p. is already taken, in motors ranging from 2.5 to 165 h. p., the greatest power taken by any one establishment being 200 h. p. by the Moos ironworks at Lucerne. The average does not exceed 25 h. p.

Special Subjects at the Paris Exposition.

LA REVUE TECHNIQUE for March 10 contains a curious list of special exhibits or projects which have been submitted to the management of the Paris Exposition of 1900. It will be seen that none of these offers so conspicuous a feature as either the Eiffel tower or the Ferris wheel, but at the same time there are a number of projects in the list which, if properly executed, would doubtless add greatly to the attractiveness of the display.

Among the subjects proposed we note:

A revolving building in which visitors, while resting, may behold successively all portions of the view;

An historical exhibition of chromo-photography, as well as of scenes in motion (cinematograph, etc.);

Several captive balloons;

Restorations of scenes in old France and of portions of old Paris;

A panorama-diorama, showing the tour of the world;

Reproductions of vessels,—a cruiser and an ocean steamer;

Traveling sidewalks;

A history of costume;

Tableaux of the progress of the nineteenth century;

Illuminated fountains;

Illumination effects on the river Seine;

A scientific congress, especially for the discussion of current problems, such as aerial navigation, photography in colors, vision at a distance, etc.;

Reproductions of mining operations.

Some of these are well-known adjuncts to modern expositions; others are more or less visionary, or of minor importance; no doubt a judicious selection will be made.

The Microphonograph.

BOTH the microphone and the phonograph are well-known instruments, and their combination has furnished an apparatus which has, for some purposes, most useful applications.

The microphonograph has been devised especially for physiological purposes by Professor Dussaud of Geneva, and a description of it is given in *Le Génie Moderne* for February 15.

The repeating microphonograph is intended for use in the treatment of deaf mutes, especially in teaching those in whom there exists the ability to hear very faint sounds, and those in whom the gradually-returning sense of hearing is to be developed. This apparatus consists of an ordinary phonograph with a microphone transmitter attached to the diaphragm, so that, by use of a telephone receiver, the utterances of the phonograph may be made audible to a person possessing only a very feeble sense of hearing. The strength of current required varies with the condition of the patient, and it has been found that in some cases thirty cells of battery were needed at first, while ultimately the same person could hear distinctly with but one cell. By using a judicious selection of cylinders, persons otherwise shut out almost entirely from audible communication with the world may thus be enabled to hear; and special communications may be spoken into the usual phonograph receiver, and the cylinder then used in the microphonograph.

The recording microphonograph is practically the reverse of the repeating instrument; it consists of a microphone attachment to an electrically-operated diaphragm, by which the feeblest sounds are recorded upon the phonograph cylinder. This form has proved especially useful in auscultation for pulmonary diseases and affections of the heart. Cylinders bearing the records of various cases may be preserved for use in connection with medical instruction, and heard simultaneously by a number of students.

The recording instrument may also be used most effectively in connection with psychological investigations. M. Dussaud also has the idea of using the instrument to open up, in the realm of sound, a field of investigation similar to that covered by the microscope and microphotography in the sphere of vision.

The Concentration of Sulphuric Acid.

A PAPER presented by M. Ch. Franche before the second international congress of applied chemistry upon the high concentration of mineral acids contains some points of interest which are here given from the full paper in *La Revue Technique*.

The increasing demand for sulphuric acid of a high degree of concentration, say 66° B., has developed the fact that the resistance of platinum to the action of such acid is not so great as has been generally thought. According to the investigations of Scheurer-Kestner, each ton of acid concentrated to 99.5 per cent. dissolves 9 grams of platinum. Various methods have been proposed to reduce this loss, the reduction of the exposed surface being the principle of several plans. The increasing cost of platinum stills, however, renders it desirable to do away with this loss altogether, and this has been attempted by plating the still with gold. Gold has ten times as great resistance to the boiling acid as platinum, but there has been much difficulty in obtaining a perfect adherence of the film. The best results have been obtained by Heraeus, of Berlin, who unites two pieces of gold and platinum at the fusing-point of gold, and then rolls the compound piece into sheets. It is claimed that the additional cost of the gold is saved in two years of use.

The apparatus of Faure and Kessler is intended to economize by increasing rapidity of evaporation. This is accomplished by the ingenious plan of passing through the still, above the acid, the hot dry gases from the furnace. By thus absorbing the vapor of water as rapidly as it rises from the acid, it is found possible to attain a concentration of 66° B. without raising the temperature above 170° to 200° C., while the boiling-point is 328° C. at atmospheric pressure. The fuel used is coke, and the apparatus is said to operate very satisfactorily and economically.

A New Method for Extracting Iodine.

THE present method of extracting iodine from the ashes of sea-weed by treating the kelp with sulphuric acid and peroxid of manganese and distilling the iodine out by heat is well known, but possesses disadvantages, which it is proposed to remove by a new process described in *La Revue Technique* (Feb. 10) by M. Alfred Boudon.

Instead of calcining the sea-weed, the new process treats it in the wet raw state, just as it comes from the water, thus retaining all the valuable fertilizing properties of the organic portion of the sea-weed in the residue. The delicate operation of volatilization and condensation is also avoided.

The principles involved in the new process are as follows: 1. If the raw sea-weed is treated with sea-water which has been rendered alkaline and deprived of its magnesia by the addition of the proper quantity of caustic lime, practically all of the iodine present will pass into solution.

2. From this solution the dissolved iodine may be entirely recovered by chemical operations conducted at ordinary temperatures.

3. The wet residue of sea-weed contains all its organic matter unaltered, as well as a good proportion of potash, and forms a very rich fertilizer.

Briefly, the details of the new process are as follows. The wet sea-weed is immersed for about twelve hours in sea-water containing eight kilograms of caustic lime to the cubic meter of water, this quantity being sufficient for half a ton of sea-weed. By this operation alone about sixty-five per cent. of the iodine is dissolved, and, by two successive infusions of six hours' duration, more than ninety per cent. of the iodine is abstracted. The mucilaginous matter in the solution is then precipitated by the addition of ferrous sulphate or caustic lime, and the clear liquid containing the iodine may be decanted off. After this has been neutralized by the addition of sulphuric acid, nitric acid is added, and the iodine is then dissolved in petroleum.

The practical operation of the process has been very satisfactory. From a ton of sea-weed containing 1.040 kilograms of iodine, 953 grams were extracted by the new method, or nearly 92 per cent. The residue of sea-weed after desiccation showed more than 50 per cent. of organic matter, 10 per cent. of potash, and 3.7 per cent. of nitrogen, forming an excellent fertilizer.

A French Trolley Road.

TROLLEY roads are yet somewhat of a novelty in France, and *La Revue Technique* gives much space to an account of the opening of the electric road at Chalons-sur-Marne.

The road, which at present operates only six cars, was opened in the presence of a great concourse by the prefect of the department and the mayor of the city, with much display of rhetorical fireworks and patriotic bunting, but is here noticed only because it shows that the overhead trolley is gaining a hold in France. Plans are being made for numerous overhead trolley lines in various cities of France, and, as we have already indicated in these columns, efforts are being made to obtain entrance for the overhead wire into Paris, in view of the necessities of transportation for the coming exposition.

An Improved Electric Furnace.

THE electric furnace has generally been used for the fusion of refractory substances on a commercial scale, but the *Elektrochemische Zeitschrift* for January illustrates a neat form intended for the distillation of metals, such as gold, silver, and copper, in the laboratory. The furnace, or, rather, crucible, is arranged to use a current of from 100 to 150 amperes between two carbon electrodes in a small chamber lined with carbon, and connections are provided so that any desired gases may be admitted, or vaporized metals discharged into suitable condensing vessels. The whole apparatus is fully described and illustrated, and its design is one which might readily be made available for many valuable investigations.

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American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
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American Magazine of Civics. *m.* $3. New York.
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Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
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Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $.4 New York.
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La Révue Technique. *b-m.* 28 francs. Paris.
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Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
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AUSTRIA.

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The Dwelling Problem in Great Cities, and its Solution. (Die Wohnungsnoth in Grossen Städten und deren Bekämpfung). Discusses the problem of providing for the rapidly increasing population of great cities, with views of recently erected apartment houses. The subject is considered entirely from a Continental standpoint. 7500 w. Oesterr Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12421. 30 cts.

EXPOSITION Buildings.

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FIRE-PROOF Floors.

Tests of Fire-Proof Floor Constructions. Report of tests made on various forms of construction, with results. 1600 w. Eng News—April 22, 1897. No. 12314. 15 cts.

FLOORS.

Computations for Monier Floors. (Ueber die Berechnung der Monier Platten.) A mathematical discussion of the computations for cement floors with the Monier System of wire reinforcement. 5000 w. Zeitschr d. Oesterr. Ing. u. Arch. Vereines—March 26, 1897. No. 12417. 30 cts.

FOUNDATIONS.

Apparatus for determining the Supporting Power of Soils. (Ueber ein Apparat zur Ermittelung der Natürlichen Tragfähigkeit des Baugrundes.) Describes improved methods of measuring the supporting power of the ground and investigates the laws by which it is governed. 4500 w. and 1 plate. Oesterr Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12422. 30 cts.

Substructure of the Commercial Cable Building. Conditions and descriptions of caissons, plans, sectional elevations, underpinning adjacent foundation by hydraulic and pneumatic process; working platform and traveling derrick; sinking caissons and profile of stratification. Ill. 1700 w. Eng Rec—April 17, 1897. Serial. 1st part. No. 12220. 15 cts.

GOTHIC Architecture.

Gothic Architecture in Northern Italy. A. C. Hutchinson. Read before the Province of Quebec Asso of Archs. Reviews the architectural environment of the Italian people of the 13th & 14th centuries, and describes features that mark the building of this period. 3000 w. Can Arch—April, 1897. No. 12270. 30 cts.

GOVERNMENT Buildings.

The New Government Offices Scheme. H. H. Statham. Abstract of a paper, with discussion, presented at meeting of the Roy. Inst. of Brit. Archs. The treatment of the buildings from an architectural point of view, and the alignment of streets are discussed. 5500 w. Builder—April 17, 1897. No. 12340. 30 cts.

LAUNDRY.

The arrangement of Public Laundrys. (Industrielle Wäschereien.) With plans of the arrangement of machinery, including hospital service. 3500 w. Gesudheits Ingenieur—Jan. 31, 1897. No. 12450. 30 cts.

STEEL Structures.

Some Recent Examples of Steel Structural Work Adopted in Various Types of Buildings. Andrew S. Biggart. Read before the Inst. of Engs. and Shipbuilders, Scotland. Deals principally with some works carried out by the author's firm, but only in a general way. Ill. 3300 w. Ir & St. Trds Jour—March 27, 1897. No. 12056. 30 cts.

STEEL Construction.

Steel Work in a Modern Power House. Harry R. Jones. Illustrated description of the new electric power house of the Metropolitan Street R. R. Co, at Kansas City, Mo. A good example of modern steel power-house construction. 900 w. Eng News—April 8, 1897. No. 12136. 15 cts.

VIENNA.

Vienna Buildings (Wiener Bauten-Album) Plates and text descriptive of old and new buildings in Vienna. 1500 w. and 6 plates. Wiener Bauindustrie Zeitung—Jan. 28, 1897. No. 12492. 45 cts.

HEATING AND VENTILATION.

ELECTRIC Heating.

Electric Heating of Niagara Falls Power Station. Orrin E. Dunlap. Illustrated description. An interesting study on the subject of electric heating. 900 w. W Elec—April 10, 1897. No. 12132. 15 cts.

The Electric Heater. H. E. Stauffer. A general illustrated description of some of the more recent forms of heaters showing how they are applied and used. 3500 w. Sci Am Sup—April 24, 1897. No. 12292. 15 cts.

FITTINGS.

Screwed Fittings for High Pressure. Hugh J. Barron. Advocates the manufacture of wrought iron or wrought or cast steel or malleable iron fittings for screwed work for heavy pressures and for all large pipe work except that used for very low pressures. 900 w. Dom Engng—April, 1897. No. 12367. 30 cts.

FURNACE Heating.

Furnace Heating. The causes why they sometimes fail to heat. Discusses location of registers, location of furnace, sizes of hot air pipes and defects in buildings. 1200 w. Dom Engng—April, 1897. No. 12364. 30 cts.

HEATING.

Heating a Mill from an Economizer. Describes the system, showing the method diagrammatically. 800 w. Eng Rec—April 3, 1897. No. 12089. 15 cts.

Heating Places of Worship and Other Buildings Not Having Regular Daily Use. Frederick Dye. Calls attention to heating by low-pressure steam, which the writer thinks especially adapted to the purpose, fulfilling every special requirement, and possessing no disadvantages. 1900 w. Dom Engng—April, 1897. No. 12369. 30 cts.

Prehistoric and Modern Heating Appliances. Robert Grimshaw. Part first traces the progress of heating appliances from the earliest times, giving illustrations of advancing stages. 1800 w. Dom Engng—April, 1897. No. 12366. 30 cts.

HUMIDITY.

The Drosophore, for the Humidification of the Air. (Humidification de l'Air; Le Drosophore.) An apparatus for maintaining the proper degree of humidity in spinning and weaving mills by a combination of atomizers and air currents. 1500 w. La Revue Technique—March 25, 1897. No. 12427. 30 cts.

OFFICE Buildings.

Heating and Ventilating Large Office Buildings. Thomas Barwick. Discusses the different systems employed giving the writer's preference, and reasons. 2000 w. Heat & Ven—April 15, 1897. No. 12242. 15 cts.

Heating of the Bowling Green Office Building, New York City. Illustrated description of a large plant requiring 23,500 lineal feet, or 4½ miles of steam and return piping. 1500 w. Heat & Ven—April 15, 1897. No. 12241. 15 cts.

RADIATING Surface.

The Utilization of Radiating Surface. A. J. Kingsley. A study of the subject with the view of finding means of discriminating as to the relative value of the different styles of radiators on the market. 1700 w. San Plumb—April 15, 1897. No. 12273. 15 cts.

SCHOOL Buildings.

Ventilation of School Buildings. S. H. Woodbridge. Considers the relation of air to vital energy, cost of air supplied, and some simple methods of ventilating. Ill. 2300 w. San Plumb—April 15, 1897. No. 12275. 15 cts.

Heating of a New Haven School. Illustrated description of the heating and ventilating plant of the Norton school building. 1300 w. Eng Rec—April 17, 1897. No. 12221. 15 cts.

STEAM Heating.

Experiments upon High and Low Pressure Steam Heating. (Beobachtungen an einer Centralheizung mit Niederdruck Abdampf und Dampf von 2 Atm. Ueberdruck.) With a total heating surface of 1405 square metres, steam at 30 pounds gave 740 calories per square metre per hour, and steam at 3.5 lbs., 460 calories. Full details of the test are given. 4500 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12423. 30 cts.

Defective Drainage in Steam Pipes and Its Results. Calls attention to facts which show the intense strain to which pipes are subjected where water is allowed to rest in them. 1,000 w. San Plumb—April 15, 1897. No. 12274. 15 cts.

High Pressure Heating. Frederick Dye, in Building World, London. Discusses this method of warming buildings, its advantages and disadvantages. 1800 w. Dom Eng—April, 1897. Serial. 1st part. No. 12365. 30 cts.

VENTILATION.

See same title under Railroad Affairs. Miscellany.

WARMING.

A Study in Warming-Furnaces. (Eine Ofenstudie.) An account of experiments made in Norway by Dr. Henrichsen, upon the value of different fuels for house warming. 3500 w. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12443. 30 cts.

Heating by Warm Air. (Ueber Luftheizung.) Especially discussing in direct systems of steam and hot water heating, and opposing the use of direct radiators in rooms. 5000 w. Gesundheits-Ingenieur—March 15, 1897. No. 12446. 30 cts.

LANDSCAPE GARDENING.

GARDENING.

A Suburban Country Place. M. G. Van Renssellaer. Illustrated description of the beauty of Brookline, near Boston, brought about by the art of the landscape gardener. 6500 w. Cent Mag—May, 1897. No. 12517. 45 cts.

Three Mediterranean Gardens. Walter Harrington Kilham. A discussion of the style of gardening which prevails in the south of Italy and Spain, illustrating their peculiarities and suggesting their possibilities of imitation. 1300 w. Am Arch—April 10, 1897. Serial. 1st part. No. 12173. 15 cts.

LANDSCAPE ART.

The Field of Landscape-Art. Editorial talk on the requirements and outlook in this field. 900 w. Gar and For—April 28, 1897. No. 12375. 15 cts.

PARK Systems.

The Park Systems of Minneapolis and St. Paul, Minnesota. Mary C. Robbins. An account of the scheme outlined by the landscape architect, W. S. Cleveland, of the important beginning made at Minneapolis, and the neglect of St. Paul. 1800 w. Gar and For—April 28, 1897. No 12376. 15 cts.

PLUMBING AND GASFITTING.

APARTMENTS.

Plumbing in Center Court Apartments. Decription, with illustrations, of the plumbing of a five story brick building on West 28th St.,

New York. 1100 w. Eng Rec—April 10, 1897. No. 12179. 15 cts.

DRAINAGE.

Modern Standards for House Drainage. Gives the series of by-laws drafted by the London County Council, which it is proposed to enact into law, which will give a uniform drainage practice to the entire metropolitan area. 2000 w. Dom Engng—April, 1897. Serial. 1st part. No. 12363. 30 cts.

PLUMBING.

Plumbing in the Bank of Commerce Building. Part first contains a general description, requirements of materials and workmanship, system of water distribution and drainage, conventional diagrams of arrangement of water service and typical riser lines. 2000 w. Eng Rec—April 24, 1897. Serial. 1st part. No. 12339. 15 cts.

SANITATION.

Sanitary Appliances. W. M. Watson. Objections to sanitary rules in force in Toronto, with reasons. Ill. 2700 w. Can Eng—April, 1897. No. 12188. 15 cts.

SOIL PIPES.

English Soil Pipes, and How Plumbers Run Them. A few details of soil pipe work, with illustrations. 1000 w. Dom Engng—April, 1897. No. 12362. 30 cts.

MISCELLANY.

ARCHITECTURE.

Eighteenth Century Work. J. A. Gotch. Read at meeting of the Architectural Assn., London. Points out the advantages and disadvantages of the styles. An interesting paper. Followed by discussion. 9000 w. Builder—March 27, 1897. No. 12059. 30 cts.

HANDICRAFTS.

Architecture in Relation to the Handicrafts. T. G. Jackson. Read at meeting of the British Arch. Assn. The authority of noted writers on architecture is given, the modern system discussed, and the changes in conditions which must be met, with the writer's suggestions. 5500 w. Arch, Lond—April 9, 1897. No. 12245. 30 cts.

INTERIORS.

Modern House Interiors. T. Butler Wilson. Read before the Leeds and Yorkshire Arch. Soc. Extract. Arguing that the whole decorative scheme of the interior should be the business of the architect. 2000 w. Arch, Lond—April 9, 1897. No. 12244. 30 cts.

LEAD.

Lead Work. W. R. Lethaby. Read before the Soc. of Arts. Abstract. Discusses lead cisterns, fountains and conduits; lead roofs, spires, domes, and belfrys, and ornamental lead work. 3300 w. Brit Arch—April 16, 1897. No. 12341. 30 cts.

LEADED GLASS.

Stained and Leaded Glass Work. Richard Matthews. History of the manufacture; part first is confined to ancient work. Illustration. 1700 w. Ill Car & Build—April 16, 1897. Serial. 1st part. No. 12319. 30 cts.

LONDON.

The "Uglification" of London. Editorial criticism of various works which have been carried out in London and its suburbs. 2500 w. Builder—March 27, 1897. No. 12058. 30 cts.

MEDIAEVAL Architecture.

Heraldry in English Mediæval Architecture. W. H. St. John Hope. The paper is confined to the period from 1216 to 1547, showing how far heraldry and architecture were associated. Illustrated descriptions of early applications are given. Full paper, with discussion. 9800 w. Jour Roy Inst of Brit Arch—March 18, 1897. No. 12324. 75 cts.

MONUMENT.

The Imperial Monument in Berlin. (Das Kaiserdenkmal auf der Schloss Freiheit zu Berlin) Fully illustrated account of the monument to the memory of the Emperor William I, recently unveiled in Berlin. Two articles, 1 plate. 4500 w. Deutsche Bauzeitung—March 20, 27, 1897. No. 12488. 30 cts.

The Imperial Monument on the Kyffhaüser. (Das Kaiser-Denkmal auf dem Kyffhaüser). With illustrations from photographs, of the fine Barbarossa monument. Two articles & 1 plate. 2500 w. Deutsche Bauzeitung—Feb. 27 & March 6, 1897. No. 12487. 30 cts.

The Leipzig National Monument. (Das National-Denkmal bei Leipzig.) Description with illustrations, of the designs submitted in the competition for the monument to be erected upon the battle field of Leipzig. Two articles—2500 w. 1 plate. Deutsche Bauzeitung—Jan. 16,23, 1897. No. 12486. 30 cts.

PARTHENON.

The Doom of the Parthenon. J. R. S. Sterrett, in the "Evening Post." Describes the state of general dilapidation, and predicts an early collapse. 1000 w. Arch & Build—April 10, 1897. No. 12145. 15 cts.

PUEBLO.

Pueblo Architecture. Cosmos Mindeleff. Illustrated description of aboriginal American house structures. 2000 w. Am Arch—April 17, 1897. Serial. 1st part. No. 12237. 15 cts.

PYRAMIDS.

Pyramids and their Relation to Monumental and Sacred Architecture. Cyrus K. Porter. Considers the monumental pyramids of Egypt, their adaptation to the purpose of sacred architecture in Mexico and Central America, and the pyramidal shaped temples of India. An interesting, illustrated article. 5500 w. Stone—April, 1897. No. 12317. 30 cts.

ROOFING.

Roofing Slate in Ireland. Information extracted from recent reports of U. S. Consuls at Belfast and Dublin. 2500 w. Stone—April, 1897. No. 12318. 30 cts.

WALES.

Art in Wales. T. E. Ellis. An address delivered before the Cymmrodorion Society. Contains interesting information of Welsh architecture and arts. 7300 w. Arch, Lond—April 2, 1897. No. 12189. 30 cts.

WOODS.

Summary of Mechanical Tests on Thirty-two Species of American Woods. Statement of results of the timber investigations carried on by the Div. of Forestry. The object of these investigations is to increase the general knowledge of the properties and behavior of wood and to discover facts that will enable the consumer to judge of the comparative value. 4000 w. U. S. Dept of Agri—Circ. No. 15. No. 12215. 45 cts.

CIVIL ENGINEERING.

BRIDGES.

BRIDGES.

See same title under Railroad Affairs, Maintenance of Way.

FOUNDATIONS.

The Distribution of Pressure in Stepped Foundations. (Ueber die Druckvertheilung in Absatzweise Verbreiterten Mauerwerksfundamenten.) An examination of the manner in which the pressure of a pier is transmitted to the extended portion of the foundation. 2500 w. Zeitschr d. Oesterr. Ing. u. Arch. Vereines—March 26, 1897. No. 12418. 30 cts.

LIFT BRIDGE.

The New Huron Street Lift-Bridge, Milwaukee, Wis. M. G. Schinke. Detailed description with illustrations. 1800 w. Eng News—April 22, 1897. No. 12313. 15 cts.

PLATE GIRDER.

The Transportation and Erection of a Plate Girder Highway Bridge. Description of the transportation of the material and the erection of a plate girder bridge, built by the Wabash Bridge & Iron Works. An interesting study of simple and effective methods of overcoming difficulties. Ill. 1800 w. Eng News—April 15, 1897. No. 12204. 15 cts.

ROCK ISLAND Bridge.

Erection of the Draw Span of the New Rock Island Bridge. Ralph Modjeski. An interesting illustrated description going into details, and followed by short discussion. 9200 w. Jour W Soc of Engs—April, 1897. No. 12398. 45 cts.

STEEL.

See same title under Mining and Metallurgy, Iron and Steel.

TRUSSES.

Trusses with Suspended Horizontal Thrust. (Bogenträger mit Aufgehobenem Horizontalschub.) A design for arched trusses, whereby the horizontal thrust may be converted into a vertical pull sustained by a tension member anchored in the pier. 2000 w. Zeitsch d Vereines Deutscher Ingenieure—March 20, 1897 No. 12407. 30 cts.

CANALS, RIVERS AND HARBORS.

CANAL.

A Black Sea and Baltic Canal. Description, with map, of the route proposed, work, cost, &c. 800 w. Eng, Lond—April 9, 1897. No. 12-238. 30 cts.

Canadian Waterways and the Canadian Tariff. A statement of two important announcements from Canada. First, the decision to begin the enlarging of the canal system connecting the great lakes and St. Lawrence; second, the decision to discriminate against the United States, in favor of Great Britain, in the new tariff bill. 900 w. Trans—April 2, 1897. No. 12158. 30 cts.

Canal Communication from the Midlands to the Sea. A brief review of the four main routes which are referred to as of prime importance to the Midlands, with other information. 3000 w. Eng, Lond—March 26, 1897. No. 12098. 30 cts.

EXCAVATING.

See same title under Mechanical Engineering, Miscellany.

FLOODS.

Fraser Valley Reclamation. R. E. Palmer. Describes the system of reclamation adopted, with plate showing a longitudinal section through the foundation. 3500 w. Can Soc of Civ Engs—April 8, 1897. Advance Proof. No. 12315. 45 cts.

The Mississippi Flood. Brief illustrated account of the recent flood and the damage done by it. 1700 w. Harper's Wk—April 17, 1897. No. 12194. 15 cts.

The Floods of the Mississippi River. William Starling. A paper prepared before the recent flood. Part first is an interesting illustrated description of the basin, and the influences causing the floods. 7700 w. Eng News—April 22, 1897. Serial. 1st part. No. 12309. 15 cts.

National Interest in the Mississippi. Discussion of the flood situation. 1200 w. Bradstreet's—April 17, 1897. No. 12218. 15 cts.

LOCK.

Deepening a Canal Lock. Brief description of special methods adopted in the modification of the existing locks of the Erie Canal so that they will conform to the increased draft of water secured in other parts of the canal. Ill. 600 w. Eng Rec—April 10, 1897. No. 12178. 15 cts.

NICARAGUA.

Nicaraguan Ports and the Nicaragua Canal. Discusses the necessity for and advantages of the canal and the ports where the greatest extension of trade may be expected. 1700 w. Bd of Trd Jour—April, 1897. No. 12392. 30 cts.

Surveying in Nicaragua. J. Francis Le Baron. Experiences in work on the interoceanic canal; location, climatic peculiarities, animal and insect pests. 3800 w. Eng Rec—April 24, 1897. No. 12337. 15 cts.

IRRIGATION.

CANAL Irrigation.

Canal Irrigation in Modern Mexico. C. P. MacKie. Descriptive of the Tlahualilo canal system and its construction. Ill. 3800 w. Eng Mag—May, 1897. No. 12580. 30 cts.

IRRIGATION Farm.

An Experimental Irrigation Farm at Bellary. Discussion of the proposed plan of experimental farms being opened to promote agricultural education in the Madras Presidency. 1500 w. Ind Engng—March 6, 1897. No. 12184. 45 cts.

MISCELLANY.

BEAMS.

See same title under Mechanical Engineering, Miscellany.

HIGHWAYS.

The Construction Methods of the Massachusetts Highway Commission. A description of the different classes of roads with some of the general principles. 3000 w. Eng Rec—April 3, 1897. No. 12087. 15 cts.

INSTITUTION of Civil Engineers.

A Change in the Requirements for Admission to the Institution of Civil Engineers. The age of admission raised, examination required &c. Commented upon editorially. 1400 w. Eng News—April 22, 1897. No. 12310. 15 cts.

INSTRUMENTS.

Early History of Instruments and the Art of Observing in Astronomy and Civil Engineering. Charles S. Howe. Briefly traces the history from the time of the gnomon and the astrolabe to that of the transit circle and the altazimuth, &c., closing with the beginning of modern instruments. 4000 w. Jour Assn of Engng Soc—March, 1897. No. 12513. 30 cts.

MONTANA.

Address before the Montana Society of Civil Engineers. John Herron. The retiring president gives a summary of the engineering progress in the state, with a statement of the needs of the society. 3800 w. Jour Assn of Engng Soc—March, 1897. No. 12511. 30 cts.

RATING.

Rating of Engineering Undertakings. P. Michael Faraday. Read at meeting of the Soc. of Engs. Discusses the methods by which these undertakings are assessed—with some details in the application to particular hereditaments. 3800 w. Arch, Lond—April 9, 1897. No. 12246. 30 cts.

TIMBER.

Preservation of Timber. John D. Isaacs. Descriptions of methods of timber preservation given in a paper which was published in a report by the state mineralogist of California. 2900 w. Ry Rev—April 24, 1897. No. 12373. 15 cts.

WAR Material.

The Transformations of Material of War. (Les Transformations du Matériel de Guerre.) An interesting article by Col. Fix, reviewing the past and probable future of applied engineering in modern warfare. 3500 w. La Revue Technique—March 25, 1897. No. 12429. 30 cts.

BETON.

The Computation of Béton Beams. (Zur Berechnung der Betonbalken.) Records of tests of beams of béton after different times of setting; surtaining the correctness of Navier's theory. 3500 w. Zeitscher. d. Oesterr. Ing. u. Arch. Vereines—March 12, 1897. No. 12413. 30 cts.

CEMENT.

Slag Cement (Le Ciment de Laitier). An account of the manufacture of slag cement at Vitry-le-François, with data as to the precautions to be observed to insure success. 1000 w. Moniteur Industriel—Feb. 13, 1897. No. 12491. 30 cts.

ENGINEER.

The Status of the Engineer. George F. Swain. Considers the engineer's standing as compared with other professions, and his defects and their remedies. 3800 w. Jour Asso of Engng Soc—March, 1897. No. 12514. 30 cts.

GREAT Lakes.

The Control of the Levels of the Great Lakes. W. A. Jones. Showing that it is possible, by a system of dams at the outlets of the Great Lakes, to maintain their surfaces at a constant level, and thereby facilitate navigation and commerce. 2900 w. Eng Mag—May, 1897. No. 12583. 30 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

AGRICULTURAL MACHINERY.

Customs Duties on Agricultural Machinery in Foreign Countries. Statement, prepared at the Board of Trade, showing the rates leviable in the principal European countries and the United States, on machinery and implements imported from the United Kingdom. 800 w. Bd of Trd Jour—April, 1897. No. 12393. 30 cts.

ARGENTINE REPUBLIC.

United States Trade in the Argentine Republic. A table prepared to illustrate the position which the United States occupies in comparison with other countries; also report of tariff on the articles enumerated, and other information. 5000 w. Cons Repts—April, 1897. No. 12397. 45 cts.

COMMERCE.

The United States of America and the Far East. Editorial on work of the U. S. National Assn. of Manufacturers, and information given in their recent report. 2300 w. Engng—April 23, 1897. No. 12563. 30 cts.

COMPETITION.

German Competition with British Manufacturers in the Netherlands. W. Robinson. Extract from a report issued by the foreign office, reviewing the situation and expressing an opinion as to what are the chief obstacles to an extension of British trade. 900 w. Eng, Lond—March 26, 1897. No. 12099. 30 cts.

DUTIES.

Senator Elkins' Speech for Discriminating Duties. A speech in behalf of American shipping, to be published in five parts. Also editorial. 3300 w. Sea—April 8, 1897. Serial. 1st part. No. 12134. 15 cts.

EXPORTS.

Our Export Trade. Charles R. Flint. Reviews the industrial life of the past, the changed conditions, the necessity for widening our field of distribution, and the steps to be taken, and the effect a great export trade would have on the United States. 3400 w. Forum—May, 1897. No. 12554. 30 cts.

EXPOSITION.

The Russian Exposition at Nijni-Novgorod.

(L'Exposition Nationale Russe de Nijny-Novgorod.) A general review of the present state of Russian industries, from a report made to the French Society of Civil Engineers. 7500 w. Moniteur Industrielle—Jan. 2, 1897. No. 12489. 30 cts.

GERMANY.

German Capital and German Industry. The interest taken in industrial enterprises and the causes which have made these enterprises safe investments. 1200 w. Cons Repts—April, 1897. No. 12396. 45 cts.

ITALY.

Competition with British Trade in Italy. Discusses some of the important factors favoring German competition. 2500 w. Bd of Trd Jour—April, 1897. No. 12391. 30 cts.

JAPAN.

Japan. Its Resources, Industries, and Markets, with Special Reference to British Trade. Considers Japan first as a customer, and second as a competitor, giving much interesting information of the country. 10000 w. Ir & Coal Trds Rev—April 9, 1897. No. 12249. 30 cts.

PRICES.

The Late Prices Reaction. A table of comparative prices of 108 stable articles, raw and manufactured products, produce, cattle and meats, at quarterly intervals, showing fluctuations in quotations from July 1, 1892, to April 1, 1897, covering the period of recent extreme depression, with comment. 4000 w. Bradstreet's—April 10, 1897. No. 12144. 15 cts.

RUBBER Shoes.

A Short History of Rubber-Shoe Prices. The problem of prices, its importance, lists of prices in 1852 and 1864, &c. 1400 w. Ind Rub Wld—April 10, 1897. No. 12383. 45 cts.

The Reduction in Rubber-Shoe Prices. Statements regarding the rubber-shoe trade showing that prices average 16% lower than last year. 4400 w. Ind Rub Wld—April 10, 1897. No. 12382. 45 cts.

SCIENTIFIC Apparatus.

Should the Manufacture of Scientific Apparatus in this Country Be Protected and Encouraged by a Tariff? A. A. Ziegler. Favoring a duty and discussing this question. 2000 w. Elec Rev—April 14, 1897. No. 12191. 15 cts.

TARIFF.

Comparison of Iron and Steel Duties in the Wilson Tariff and the Dingley Bill. A careful comparison of the duties on iron and steel and manufactures of iron and steel. 1700 w. Bul of Am Ir & St Assn—April 10, 1897. No. 12121. 15 cts.

Tariff Changes and Customs Regulations. Russia, Sweden, Germany, German East Africa, Belgium, France, France-Tunis, France-Madagascar, South East Africa, Italy, Austria-Hungary, Mexico, Costa Rica, United States of Colombia, Ecuador, Argentina, Siberia, South African Republic, British India, Mauritius, Sierra Leone and Queensland. 7000 w. Bd of Trd Jour—April, 1897. No. 12394. 30 cts.

The Dingley Tariff Bill. Robert P. Porter. Discusses tariff bills in general and the Dingley bill in particular, in a manner quite favorable to the bill. 3800 w. N Am Rev—May, 1897. No. 12509. 45 cts.

TRADE.

Japan and Australia. Editorial comment on a new line of steamers inaugurated between these countries, and the effect on trade. 1300 w. Engng—April 16, 1897. No. 12352. 30 cts.

TRUSTS.

Industrial Combinations. George T. Oliver. Explains consolidations, trusts, pools, &c., their operations, and good and evil effects, with arguments advanced by the advocates of these organizations. Also suggests a plan for solving the problem of industrial combinations. 4000 w. Forum—May, 1897. No. 12555. 30 cts.

"Trusts" in Japan. Editorial comment on the economic conditions relating to the evolution of commerce and industry in the direction of combination. 1000 w. Engng—April 23, 1897. No. 12561. 30 cts.

CURRENCY AND FINANCE.

FINANCE.

The Austrian Budget for 1897. (Das Oesterreichische Finanzgesetz für das Jahr 1897.) The detailed government report, giving the estimates and expenses for all the engineering and building improvements in the Empire. Valuable for statistical purposes. 15000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—March, 1897. No. 12419. 30 cts.

PRODUCTION.

The Increased Production of Gold. Galusha A. Grow. Conclusion of a speech in the House of Representatives. Showing that there is gold enough in the world for standard money. 1300 w. Bul of Am Ir & St Assn—April 20, 1897. No. 12280. 15 cts.

GOVERNMENT CONTROL.

TRAFFIC.

Traffic Legislation. Editorial review of a lecture by J. H. Balfour Browne, delivered before the London Chamber of Commerce, giving the history of English legislation in connection with this subject. 1700 w. Engng—April 16, 1897. No. 12350. 30 cts.

TRANS-MISSOURI.

The Trans-Missouri Case. Full text of the opinion of justices White, Field, Gray and Shiras who dissent from the opinion of the majority of the U. S. Supreme Court. Also editorial. 12500 w. Ry Age—April 2, 1897. No. 12061. 15 cts.

LABOR.

ARBITRATION.

Arbitration in the Northeastern Dispute. A recapitulation of the facts with comment. 1800 w. Trans—April 2, 1897. No. 12157. 30 cts.

BANKING.

Governmentalism versus Individualism in Relation to Banking. Austin W. Wright. Reply to an article in Gunton's Mag. entitled "How Not to Reform the Currency," in which the views of the writer, as expressed in a previous article, were criticised. 6000 w. Elec Engng—May 1, 1897. No. 12589. 15 cts.

LABOR.

Employer and Employé. (Brief account of a meeting of railway officers and Brotherhood Men at Grand Rapids. 2500 w. Ry Age—April 9, 1897. No. 12151. 15 cts.

MISCELLANY.

EDUCATION.

Industrial Education. R. H. Thurston, in the N. Y. Tribune. The lesson taught by Germany in her great governmental system of technical education and its results. 2000 w. W Elec—April 24, 1897. No. 12302. 15 cts.

IMMIGRATION.

Should Immigration Be Restricted? Simon Greenleaf Croswell. Setting forth and investigating facts bearing upon the problems involved and the conclusions to which they point. 4400 w. N Am Rev—May, 1877. No. 12507. 45 cts.

MEXICO.

American Enterprise in Mexico. Comment on the experience of American capitalists who have invested their resources in Mexican railways. 1000 w. Engng—April 16, 1897. No. 12353. 30 cts.

PROGRESS.

Progress of the United States. Michael G. Mulhall. Part I. The New England States. Studies the subject from the views of population, industry and wealth. 2400 w. N Am Rev—May, 1897. Serial. 1st part. No. 12-508. 45 cts.

ELECTRICAL ENGINEERING.

LIGHTING.

ALTERNATING CURRENT.

Profitable Day Load in Alternate Current-Systems. George T. Hanchett. Suggestions for combining a lighting system with power distribution during the day. Also editorial criticism. 2000 w. Elec Wld—April 24, 1897. No. 12348. 15 cts.

See same title under Electrical Engineering. Power.

ARC Lamps.

Arc Lamps for Street Lighting. Thomas Hesketh. A consideration of the qualifications desirable. 1200 w. Elect'n—April 9, 1897. No. 12248. 30 cts.

BELGIUM.

Coöperative Electric Lighting in the Village of Borsbeke, Belgium. H. Schoentjes. An account of the electric lighting system of this small commune. 1000 w. Elec Eng—April 28, 1897. No. 12378. 15 cts.

CENTRAL Stations.

Combination of Central Electric Lighting Stations with Water Works. (Elektrische Beleuchtungszentralen in Verbindung mit Wasserwerken.) Discussing the economy of the combination, and showing the workings of the central station at Cologne. 1500 w. Die Elektrizität—Feb. 27, 1897. No. 12475. 30 cts.

COMPOSITE Station.

The Narragansett Electric Lighting Co. The Evolution of a Typical Composite Station. Joseph Wetzler. Illustrated description in detail, with editorial comment. 5500 w. Elec Eng—April 7, 1897. No. 12120. 15 cts.

FUSES.

Fuses for Branch Circuits. S. H. Sharpsteen. Considers the matter of fuse lengths for circuits of about 100 volts entering buildings for incandescent work. 1500 w. Elec Eng—April 21, 1897. No. 12282. 15 cts.

GEORGETOWN, D. C.

The Station of the Potomac Light and Power Company, Georgetown, D. C. N. Monroe Hopkins. Illustrated description. 400 w. Elec Eng—April 28, 1897. No. 12377. 15 cts.

INCANDESCENT Lamp.

Conductivity of Incandescent Carbon Filaments, and of the Space Surrounding Them. John W. Howell. The first part of the paper is in the nature of a discussion of a paper read by Prof. Anthony; and the second part is a discussion of the paper upon the "Edison Effect" in incandescent lamps which was read by Prof. Houston. Discussion follows. 10000 w. Trans Am Inst of Elec Engs—Feb., 1897. No. 12111. 45 cts.

Some Notes on the Manufacture of Incandescent Lamps. Fred De Land. Part first describes the process of properly preparing the filaments. 1500 w. Elec Engng—April 15, 1897. Serial. 1st part. No. 12233. 15 cts.

The Economy of Incandescent Lamps. (Ueber Oekonomie von Glühlampen.) A paper by Dr. Weber before the Electrotechnical Society, maintaining the greater economy of the incandescent electric lamp over the Welsbach gas burner. 1000 w. Elektrotechnische Zeitschr—March 25, 1897. No. 12465. 30 cts.

The Edison Lamp Connection. (Die Edison Fassung.) A discussion of the Edison screw fastening for incandescent lamps in comparison with a number of other devices for the same purpose. 4500 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12461. 30 cts.

LAMPLIGHTING.

Electric Lighting of Oil Lamps. (Ueber Elektrische Fernzündung von Oellampen.) A drop of oil is lighted by contact with an incandescent platinum wire and the resulting flame communicated to the wick. 2500 w. Elektrotechnische Rundschau—March 1, 1897. No. 12476. 30 cts.

LAMPS.

The Automatic Extinction of Lamps. Describes a device in use at Portsmouth, Eng., where each lamp pillar carries an arc lamp as well as two incandescent lamps, by which the arc lamps are automatically put out and the incandescent lighted at midnight. Ill. 1000 w. Elec Rev, Lond—March 26, 1897. No. 12-103. 30 cts.

LIGHTING.

Electric Lighting of the New Armory of the Ninth Regiment, N. G. S. N. Y. Illustrated description of an interesting installation where the entire lighting of the main drill hall is ac-

complished by means of ordinary two-in-series open arcs. 1100 w. Elec Wld—April 3, 1897. No. 12092. 15 cts.

LIGHTING Plant.

A Public Park Lighting Plant. P. M. Heldt. Describes and illustrates the new plant in Chicago which supplies current for the chain of parks and boulevards on the west side. 2000 w. Am Elect'n—April, 1897. No. 12286. 25 cts.

MALTA.

Malta Electricity Supply. Illustrated detailed description of works undertaken by the government of Malta. Interesting to engineers and members of local authorities. 1200 w. Eng, Lond—April 2, 1897. No. 12150. 30 cts.

PHOTOGRAPHY.

Electricity and Photography. Details of electrical apparatus used in a studio making it possible to take photographs at any time, irrespective of the state of the atmosphere. Ill. 1300 w. Elec Eng, Lond—March 26, 1897. No. 12101. 30 cts.

NORWICH, England.

Electric Lighting in Norwich, England. Herbert C. Gunton and Harold Lomas. Illustrated detailed description. 1500 w. Elec Wld—April 10, 1897. No. 12171. 15 cts.

RECONSTRUCTION.

Reconstruction of the Alternating Current System of the Royal Electric Company, Montreal, Canada. P. G. Gossler. An illustrated account of the reconstruction of an alternating current system supplying current to a large territory. 2700 w. Can Elec News—April, 1897. No. 12129. 15 cts.

STORAGE Battery.

Storage Battery Plant in a Brooklyn Lighting Station. Illustrated description of an interesting accumulator installation in the second district station of the Edison Illuminating Co. 1000 w. Elec Rev—April 7, 1897. No. 12105. 15 cts.

The Scotia Street Storage Battery Station of the Boston Edison Co. Illustrated description. 1200 w. Elec Eng—April 21, 1897. No. 12281. 15 cts.

WORCESTER.

The Extension at Worcester. Information from the report of Mr. Ruthven Murray, the city electrical engineer. Day plant, switchboard, sliding scale and no meter rent. 1600 w. Elec Rev, Lond—April 2, 1897. No. 12168. 30 cts.

POWER.

ACCUMULATORS.

Accumulators for Rapid Charging. L. Epstein. Reviews the opinions of M. Blanchon as expressed in a paper read before the Société International des Electriciens, and objects to his conclusions. 1500 w. Elec Rev, Lond—April 16, 1897. No. 12322. 30 cts.

Tests of a Gülcher Accumulator. (Untersuchung eines Gülcher-Akkumulators.) The Gülcher plate is composed of lead wires and spun glass. Tests under various conditions of charging and discharging show excellent efficiency, with much less weight than existing forms. 3000 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12462. 30 cts.

The Ribbe Accumulator. Illustrated description of an accumulator which the inventor claims to be especially adapted to the propulsion of cars or other vehicles. 1400 w. Eng, Lond—April 23, 1897. No. 12534. 30 cts.

See same title under Electrical Engineering, Telegraphy and Telephony.

ALTERNATING Current.

Alternating Current Dynamos in Parallel. J. E. Woodbridge. Describes treatments which seem to work well in practice. 2800 w. Elec Eng—April 28, 1897. Serial. 1st part. No. 12381. 15 cts.

Recent Developments in Alternate Current Machinery, with Special Reference to the Ganz System. Alfred Dubsky. A short description of the newer alternating current machinery which has been constructed at the Ganz works at Budapest during the last few years. 2700 w. Elect'n —April 16, 1897. Serial. 1st part. No. 12360. 30 cts.

The Transmission of Power to Long Distances by Alternating Currents of Electricity. W. B. Esson. Discusses the subject under the headings of generators, conductors, and motors. Discussion follows. 12000 w. Jour of Soc of Arts —March 26, 1897. No. 12060. 30 cts.

See same title under Electrical Engineering, Light.

CURRENTS.

Electric Currents and Subdivision Systems. (Elektrische Strom und Stromverteilungssysteme.) A series of articles of a general and descriptive character, rather elementary. 10000 w. 5 articles. Die Elektrizität—Jan. 2, 16, Feb. 13, March 13, 27, 1897. No. 12471. 30 cts. each number.

Utilization of Multi-Phase Currents in Electric Driving. Percy Nicholls. Deals with the advantages of, or objections to, the system for short distance transmission, and the principles underlying the construction and action of these machines. Ill. 3600 w. Prac Eng—April 9, 1897. No. 12236. 30 cts.

ELECTRIC Plant.

Electric Light, Power and Heating Plant at the Rothschild Shirt Factory, Trenton, N. J. Illustrated description. 2400 w. Elec Wld—April 17, 1897. No. 12278. 15 cts.

ELECTRIC Power.

See same title under Marine Engineering.

ELEVATOR.

A Safety Electric Elevator. (Bahnartig Betriebener Elektrischer Sicherheits Aufzug.) The car revolves around its vertical axis and screws its way up a spiral track carried around the interior of the circular shaft. 1500 w. Deutsche Zeitschr für Elektrotechnik—February, 1897. No. 12455. 30 cts.

Electric Elevators. A brief review of hoisting mechansms used since the earliest ages is given, and the early history of the electric motor as applied to elevator machinery. Ill. 2500 w. Elec Wld—April 3, 1897. Serial. 1st part. No. 12091. 15 cts.

FACTORY.

Electricity in an Oil Cloth Factory. S. Ashton Hand. Illustrated description of the power and lighting plant recently installed in the factory of the Farr & Bailey Mfg. Co., of Camden, N.

J. 1000 w. Mach, N. Y.—May, 1897. No. 12570. 15 cts.

FRESNO Plant.

Some details of the Fresno Plant. C. E. Dutcher. Illustrated description of technical details of the electrical operation of the plant. 4500 w. Jour of Elec—April, 1897. No. 12371. 15 cts.

GENERATORS.

See same title under Street and Electric Railways.

HARROGATE.

Harrogate Electricity Works. Illustrated detailed description. 5000 w. Elec Eng, Lond—April 9, 1897. No. 12250. 30 cts.

HAULAGE.

See same title under Mining and Metallurgy, Mining, and title "Electric Haulage," under Railroad Affairs, Transportation.

HOISTS.

See same title under Mining and Metallurgy, Mining.

LOCOMOTIVE.

See Railroad Affairs, Maintenance of Equipment.

MOTORS.

Application of Electric Motors to the Textile Industry. (Les Applications des Moteurs Electriques a l' Industrie Textile.) Shows motors operating line shafting and also independent looms as applied in Switzerland and France. 2500 w. La Revue Technique—March 25, 1897. No. 12424. 45 cts.

Asynchronous Alternating Motors. (Ueber Asynchrone Wechselstrommotoren.) A mathematical investigation of the conditions of best action and efficiency of one- and three-phase electric motors. 2500 w. Elecktrotechnische Zeitschr—March 25, 1897. No. 12464. 30 cts.

MULTIPHASE.

Multiphase Generators and Motors. (Die Drehstrom-Dynamomaschunen und Drehstrom-Motoren.) A general explanation of the principles together with an illustrated description of the machines of the Allgemeine Elektrizitäts-Gesellschaft of Berlin. Three articles, 7500 w. Die Elektrizität—Feb. 27, March 13, 27, 1897. No. 12474. 30 cts. each.

NIAGARA.

Electrical Development at Niagara Falls. The demands for power and the arrangements being made to supply; a brief description of the new wheel pit, &c. Ill. 600 w. Elec Rev—April 14, 1897. No. 12190. 15 cts.

PHILADELPHIA.

Cause of Fire at Union Traction Company's Power House, Philadelphia. Report of William McDevitt to the Philadelphia Fire Underwriters' association. 1000 w. W Elect'n—May 1, 1897. No. 12524. 15 cts.

POWER Plant.

Power Plant of the Tennessee Centennial and International Exposition at Nashville, Tenn. Brief illustrated description. 500 w. Power—May, 1897. No. 12558. 15 cts.

POWER Transmission.

Electric Power Transmission Project in the Mohawk Valley. Orrin E. Dunlap. Brief account of the project for developing the power of West Canada Creek at Trenton Falls. Ill. 500 w. W Elect'n—May 1, 1897. No. 12523. 15 cts.

Electricity—Including a Short Review of Transmission of Power by Electricity and Compressed Air. F. B. Griffith. A non debatable paper. Presents a few rules and principles which were evolved by experiments made by eminent electricians, points out some of the uses and advantages of electricity in railroad shops, &c. Ill. 1600 w. Pro of Cent R'way Club—March, 1897. No. 12234. 45 cts.

Electric Power Transmission in Factories. Describes the recent installation of Messrs. Chadwick, Limited, with remarks. The plant is considered very complete. 2500 w. Elec Rev, Lond—April 16, 1897. No. 12320. 30 cts.

The Rheinfelden Power Transmission. The history of the scheme, with description of the power house, turbines, plant and distribution. Ill. 3500 w. Elect'n—March 26, 1897. No. 12096. 30 cts.

PUMPING by Electricity.

See "Electric Pumps" under Municipal Engineering, Water Supply.

RESISTANCE.

A Practical Resistance Device. (Ein Praktischer Belastungs-Wiederstand.) A resistance for testing generators, &c., composed of sheet-iron plates immersed in casks of water. A constant stream of water flows through the casks, maintaining a uniform temperature. 1500 w. Deutsche Zeitschr. f. Elektrotecknik—February, 1897. No. 12454. 30 cts.

SAW MILL.

Electric Saw Mill at Folsom, Cal. Illustrated description of the application of electric power to the driving of saw mills. 600 w. Elec Eng—April 28, 1897. No. 12379. 15 cts.

TIFFANY Factory.

Electric Power Plant of the Tiffany Factory at Forest Hill, N. J. Illustrated description of this recent installation. 1100 w. Elec Wld—April 10, 1897. No. 12170. 15 cts.

TRACTION.

See "Haulage," above; "Electricity," under Railroad Affairs, Miscellany; and "Electric Traction" under Street and Electric Railways.

TRANSFORMERS.

Formulæ for Transformers. Alexander Russell. In proving the formulæ in this paper no assumptions have been made as to the shape of the curve of the applied electromotive force, or as to the shape of the permeability curve of the iron core. Formulæ are found for the ordinary transformer with a non-inductive load, then with inductive loads and condenser loads. Also methods of boosting and compensating are discussed. 4500 w. Elect'n—March 26, 1897. No. 12097. 30 cts

TELEGRAPHY AND TELEPHONY.

ACCUMULATORS.

The Installation of Accumulators at the Main Telegraph Office in Paris. (Akkumulatorenein richtung auf dem Haupt Telegraphenamt in Paris.) Since 1895, 11000 Calland cells have been replaced by Tudor, and Laurent-Cély storage batteries, of which full details are given. 3000 w. Elektrotechnische Zeitschr—March 18, 1897. No. 12463. 30 cts.

BELL Telephone Co.
The American Bell Annual Report. The extent of the service and amount of yearly business. 2000 w. Elec Rev—April 28, 1897. No. 12390. 15 cts.

BERLINER Case.
The Probable Decision in the Berliner Case. E. F. Frost. An attempt to forecast the outcome of this case, predicting that the Government will win its suit to annul the Berliner patent on every count. 1200 w. Elec Wld—April 17, 1897. No. 12276. 15 cts.

CABLE.
The German-Norwegian Cable. Alb. Petersen. Describes changes which improved the telegraphic connections between Germany and Norway to such an extent, that the cable, by means of well regulated instruments, is now able to transmit about 2⅛ times more traffic than before. Diagram. 1500 w. Elec Rev, Lond—March 26, 1897. No. 12104. 30 cts.

CABLE Speeds.
The Function of the Element in Cable Speeds. E. Raymond-Barker. Investigations of the writer, intended to give some light on this subject. A suggestion of a standard method for conducting really satisfactory trials of speed on laid cables, with the view to the data being adopted as basis for future calculations in the design of cable cores. 2500 w. Elec Rev, Lond—April 16, 1897. No. 12321. 30 cts.

CABLE Steamer.
The French Cable Steamer "Portena." Description of the third cable steamer built by Messrs. Johnson & Phillips for the Compagnie Française des Cables Télégraphiques. 1800 w. Elect'n—April 2, 1897. No. 12163. 30 cts.

RAPID Telegraph.
High Speed Telegraphy. Editorial on the system of Messrs. Crehore & Squier. 1000 w. Elec Eng—April 28, 1897. No. 12380. 15 cts.

SUBMARINE Telegraphy.
The Commencement of Submarine Telegraphy. J. H. Jackson, in the Nautical Magazine. Account of early attempts, giving the palm to a Russian scientist, Prof. Soemmering 1100 w. Sci Am Sup—April 24, 1897. No. 12293. 15 cts.

TELEPHONE Exchange.
The New Telephone Exchange in Christiana. (Das neue Fernsprechamt in Christiana.) A fully illustrated description of one of the most recent modern exchanges in Europe, with full details including the application of dynamos and storage batteries. 8000 w. Elektrotechnische Zeitsch—April 1, 1897. No. 12468. 30 cts.

A Modern Telephone Station. C. E. Kammeyer. Illustrated description of the station at the corner of 47th St. and Kedzie avenue, Chicago. 1800 w. Elec Rev—April 28, 1897. No. 12389. 15 cts.

TELEPHONE Lines.
Reconstruction of the Telephone Lines in Westchester County, N. Y. Details of improvements to be made, with schedule of charges obtaining in this district. 1000 w. Elec Eng—April 21, 1897. No. 12283. 15 cts.

TELEPHONE Rates.
Telephone Rates in New York. Argument against the Brush bill to regulate telephone charges. 1100 w. Elec Rev—April 14, 1897. No. 12192. 15 cts.

MISCELLANY.

ARMATURES.
The Reaction of Eddy Currents upon Armatures. (Die Anker Rückwirkung der Wirbelströme.) A mathematical and graphical investigation. 1500 w. Elektrotechnische Zeitschr—March 11, 1897. No. 12459. 30 cts.

BATTERIES.
Thermo-Electric Batteries. C. J. Reed. Describes the two general classes of thermo-electric batteries and their action. 3000 w. Am Elect'n—April, 1897. No. 12288. 25 cts.

CATHODE Rays.
Mr. Swinton on Cathode Rays. Some intertesting and unexpected properties as developed in the focus tube generally employed for the production of Röntgen rays, presented in a paper read before the Royal Soc. Ill. 1400 w. Elec Rev, Lond—April 9, 1897. No. 12240. 30 cts.

Some Experiments with Cathode Rays. A. A. C. Swinton. Abstract of a paper read before the Royal Society. Investigation of the discharge in Crookes' tubes. Illustrated description of experiments from which it seems that X-rays can only be produced by Cathode rays when these strike solid matter. 3300 w. Nature—April 15, 1897. No. 12323. 30 cts.

CONDUIT.
Construction of Chicago Edison Company's Underground Conduit in Jackson Street. Illustrated description of work now being executed, which embodies every advancement known to the art. 1500 w. W Elec—April 24, 1897. No. 12301. 15 cts.

CONVERTER.
A Rotating Liquid Converter. Henry S. Carhart. Describes a simple device to convert a direct current from any source, such as a storage battery, into alternating currents of one, two or three phases, and applies the principle involved to an explanation of the rotating converter. 1600 w. Am Elect'n—April, 1897. No. 12289. 25 cts.

CORES.
The Insulation of Armature Cores. Louis Illmer, Jr. Considers the manner in which the general types of armatures are insulated. Ill. 1600 w. Am Elect'n—April, 1897. No. 12-287. 25 cts.

CURRENTS.
Transmission of Heavy Currents. G. H. B. Zahn. A study of the various systems used, of conductors, and insulating materials, &c. 4000 w. W Elec—April 17, 1897. No. 12223. 15 cts.

ELECTRICAL History.
Epoch-Making Events in Electricity. G. H. Stockbridge. Considering Oersted's discovery, and Ampere's work as a logical sequence thereof. Second paper. 4300 w. Eng Mag—May, 1897. No. 12582. 30 cts.

ELECTRICITY and Magnetism.
The Nature of Electricity and Magnetism. (Das Wesen der Elektrizität und des Magnetismus.) A series of articles treating of the molecu-

lar theory of Vogt. Three articles. 7,500 w. Die Elektrizität—Jan. 2, 16, 30, 1897. No. 12472. 45 cts.

ETHICS.

Ethics of Modern Science. S. Alfred Varley. A criticism of a recent lecture by Prof. Ayrton, with remarks on electrical matters. 3000 w. Elec Rev, Lond—April 2, 1897. No. 12169. 30 cts.

FUMES.

On Electrical Properties of Fumes Proceeding from Flames and Burning Charcoal. Lord Kelvin and Dr. Magnus Maclean. Read at meeting of Royal Soc. Describes experiments made and gives results. Ill. 1800 w. Nature—April 22, 1897. No. 12591. 30 cts.

GASEOUS Fuel.

Gaseous Fuel as a Means of Cheapening Electricity. Nelson W. Perry. Suggestions for decreasing the expenses of electrical plants. 3500 w. Am Gas Lgt Jour—April 5, 1897. No. 12067. 15 cts.

INSTRUMENTS.

New Universal Register, Galvanometer and Insulation Measure by Siemens & Halske. (Ueber ein Universal Registririnstrument, Universal Galvanometer und Isolationsmesser von Siemens & Halske.) Giving full details of construction and use of three new and valuable instruments. 5000 w. Elecktrotechnische Zeitschr—April 1, 1897. No. 12469. 30 cts.

INSULATION.

Measurement of Insulation in Systems of more than Two Conductors. (Ueber Isolationsmessungen auf Systemen von mehr als Zwei Leitern, &c.) A mathematical treatment, giving analytical relations for a great variety of combinations. 7500 w. Elektrotectnische Zeitschr—March 11, 1897. No. 12458. 30 cts.

MAGNETISM.

Magnetism for Engineers. An article written for the benefit of engineers, who do not see things in the same light as the pure scientist, in an endeavor to elucidate some of those conceptions of the scientific mind which are a frequent cause of bewilderment to the electrical engineer. 3800 w. Elec Rev, Lond—March 26, 1897. No. 12102. 30 cts.

MAGNETS.

The Calculation of Wires for Magnets. George T. Hanchett. A number of formulæ for coils and cores of different sections, together with the meanings of their reference letters. 400 w. Elec Wld—April 17, 1897. No. 12277. 15 cts.

OPTICS.

I. Optics and the Theory of Ions. Dr. P. Zeeman. II. Preliminary Note upon the Broadening of the Sodium Lines by Intense Magnetic Fields. A. St. C. Dunstan, M. E. Rice and C. A. Kraus. The first article explains an important discovery, valuable from its bearing upon the theories of light and other forms of radiant energy. The second article gives experiments verifying Dr. Zeeman's discovery. 1400 w. Elec Wld—May 1, 1897. No. 12531. 15 cts.

PLANT Growth.

The Influence of Electricity upon the Growth of Plants. (Einfluss der Elektrizität auf das Wachstum der Pflanzen.) Giving an interesting résumé of the subject showing the effect to vary with the nature of the plant: also the use of electricity to destroy injurious germs. 2000 w. Die Elektrizität—Feb. 13, 1897. No. 12473. 30 cts.

REPAIRS.

Repairs of Electrical Machinery—Field Coils. A. R. Harris. How to remedy defects and the temporary expedients that may be resorted to in case of failure of field coils, is the subject of part first. 2600 w. Am Mach—April 22, 1897. Serial. 1st part. No. 12296. 15 cts.

ROENTGEN Rays.

Do the Röntgen Rays Make Air a Conductor? G. M. Minchin. Experimental study and explanations, reaching a negative result. 2300 w. Elect'n—April 9, 1897. No. 12247. 30 cts.

See also Cathode Rays, above.

THERMOELECTRICITY.

The Theory of Thermoelectricity. (Ueber die Theorie der Thermoelektrizität.) A mathematical treatment of the subject based upon the laws of the conductivity of heat. 1500 w. Elektrochemische Zeitschr—March, 1897. No. 12453. 30 cts.

TRANSFORMERS.

Practical Transformer Calculation. Franz J. Dommerque. The method of calculation is explained. 1800 w. Elec Engng—May 1, 1897. No. 12590. 15 cts.

VIBRATIONS.

Electricity and Electrical Vibrations. Review of a course of lectures recently delivered by Lord Rayleigh. The six lectures included discussion of induction, alternating currents, currents of very high frequency, vibrations, &c. 2800 w. Col Guard—April 23, 1897. No. 12564. 30 cts.

MARINE ENGINEERING.

AMERICAN Shipping.

Charles H. Cramp on American Shipping. Paper read before a conference held in the committee room of the Senate Committee on Commerce. An interesting discussion of the means and methods required for the development of our merchant marine. 1700 w. Ir Age—April 15, 1897. No. 12200. 15 cts.

See also title "Duties" under Economics and Industry, Commerce and Trade.

ARMOR PLATE.

See same title under Mining and Metallurgy, Iron and Steel.

BOILERS.

Navy Boilers. Editorial on the merits of water-tube boilers, especially the Belleville, and

support of Mr. Durston, with criticism of the Scotch boiler. 1700 w. Eng, Lond—April 16, 1897. No. 12327. 30 cts.

CABLE Steamer.

See Electrical Engineering, Telegraphy and Telephony.

CRUISERS.

Recent Trials of the Cruisers "Powerful" and "Terrible." A. J. Durston. Read before the Inst. of Naval Arch'ts. A description of the trials with data obtained therefrom. Also discussion. 10000 w. Engng—April 9, 1897. No. 12231. 30 cts.

ELECTRIC Power.

Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding. F. Von Kodolitsch. Read before Inst. of Naval Arch'ts. Shows the usefulness of light portable machine tools in marine engineering, when electrically driven. 2300 w. Ind & Ir—April 15, 1897. Serial. 1st part. No. 12346. 30 cts.

ENGINES.

New Horizontal Engines for U. S. Cruiser Chicago. Illustrated description of the new machinery with which the vessel is to be fitted. 1500 w. Marine Engng—April, 1897. No. 12107. 30 cts.

Lining a Vertical Marine Engine. James V. Trenton. Directions with diagram. 1000 w. Sta Eng—April, 1897. No. 12135. 15 cts.

FERRYBOAT.

Origin and Development of the Ferryboat. A. E. Stevens. Calls attention to the conditions which have made New York pre-eminent in the specialty of ferryboats, and briefly describes some of the early designs. Ill. 1100 w. Marine Engng—April, 1897. No. 12110. 30 cts.

GERMAN NAVY.

The Newest Vessels of the German Navy. From Ueber Land und Meer. Illustrated brief description of the Kaiser Friedrich III and the cruiser K. 600 w. Sci Am Sup—April 10, 1897. No 12122. 15 cts.

HIGH-PRESSURES.

High Steam Pressures on Sea Going Ships and in General. Dr. R. H. Thurston. Reviews the advance in pressures and expansion in part first. 1100 w. Marine Engng—April, 1897. Serial. 1st part. No. 12109. 30 cts.

IRONCLADS.

On the Fighting Value of Certain of the Older Ironclads if Re-Armed. Charles Beresford. Read before the Inst. of Naval Arch'ts. The proposal to re-arm seventeen vessels; thirteen battleships and four cruisers. Also a list giving proposed armament for each, with comments on paper and discussion. 5400 w. Eng, Lond—April 16, 1897. No. 12326. 30 cts.

JAPAN.

The Growth of a Japanese Steamship Company. Comments on information contained in a handbook issued by the Japan Mail Steamship Co. of London. The history of the growth of maritime enterprise in modern Japan is briefly reviewed. 2000 w. Engng—April 2, 1897. No. 12161. 30 cts.

LIGHT-HOUSES.

Lighthouses. Alfred J. Glasspool. Part first comments on the need of placing these signals to guide vessels in safety, and reviews the early systems and the progress made in this field. 1800 w. Arch, Lond—April 16, 1897. Serial. 1st part. No. 12357. 30 cts.

MEAN Water-Line.

The Use of the Mean Water-Line in Designing the Lines of Ships. A. G. Ramage. Read at session of the Inst. of Naval Arch'ts. Explains method, giving table of results. 600 w. Eng, Lond—April 16, 1897. 12328. 30 cts.

PROPULSION.

The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion. Chas. Parsons. Read at session of Inst. of Naval Arch'ts. Describes the fitting of the Turbinia with turbine engines, and the result as far as ascertainable. 2000 w. Eng, Lond—April 16, 1897. No. 12329. 30 cts.

REVENUE Cutters.

Machinery of U. S. Revenue Cutters Nos. 4 and 5 for the Great Lakes. Brief illustrated description. 350 w. Am Mach—April 15, 1897. No. 12255. 15 cts.

SHIP Construction.

Recent Developments in Mercantile Ship Construction. Part first calls attention to certain tendencies and developments now in progress in regard to the details of ship construction. 1500 w. Eng, Lond—April 23, 1897. No. 12533. 30 cts.

STABILITY.

Ascertaining the Stability of Ships. A. G. Ramage. Read before the Inst. of Naval Arch'ts. Illustrated description of a mechanical method of ascertaining the statical stability of ships. 1000 w. Engng—April 9, 1897. No. 12227. 30 cts.

STEERING Gear.

The Steering Gear of the Battleship Fuji. Drawings with explanatory diagrams and description of Cameron's patent self-regulating steering gear with which the ship is fitted. 1000 w. Eng, Lond—April 9, 1897. No. 12239. 30 cts.

VALVE Gears

Assistant Cylinder for Valve Gears. Basil H. Joy. Read before the Inst. of Marine Engs. Incorporated. Describes the machine and the principles, giving some practical results. 4000 w. Prac Eng—April 2, 1897. No. 12180. 30 cts.

WARSHIPS.

German and Foreign Warships. (Die Kriegsflotten Deutschlands und des Auslandes.) A comparison between the German Navy and other European powers, greatly to the disadvantage of the former. 2000 w. and large chart, Stahl und Eisen—April 1, 1897. No. 12437. 45 cts.

The United States Sea-Going Battleship "Iowa." Description with brief report of trial trip. Ill. 900 w. Am Eng & R R Jour—May, 1897. No. 12519. 30 cts.

The Alabama and the Prince George. A comparison between the dimensions and other features, with diagrams. 1800 w. Eng, Lond—April 2, 1897. No. 12149. 30 cts.

WATER-TUBE Boilers.

Water-tube Boilers in Warships. C. C. P. Fitzgerald. Read before the Inst. of Naval Arch'ts. A comparison of some of the general features of water-tube boilers with those of Scotch boilers which they are to supersede. 5000 w. Engng—April 9, 1897. No. 12230. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILERS.

Proper Construction and Care of Boilers. J. M. Allen. Read before the Southern Ice Exchange, at Charleston, S. C. Extracts dealing with how to prevent boiler explosions. 1300 w. Bos Jour of Com—April 17, 1897. Serial. 1st part. No. 12216. 15 cts.

See also same title under Marine Engineering.

CHIMNEYS.

Calculation and Construction of Tall Chimneys. (Bau und Berechnung Hoher Schomsteine.) Paper by H. Bastine before the Saxon Branch of the Society of German Engineers. A full discussion of the strength of masonry chimneys to resist wind stresses. 5000 w. Zeitsch d. Vereines Deutscher Ingenieure—March 6, 1897. No. 12403. 30 cts.

On the Construction of a Factory Chimney of the Capacity to Suit a Plant of 2000 Horse Power. Robert Kunstman. Discusses the necessary examination of the ground, the foundation, and the shaft. Ill. 2300 w. Brick—April, 1897. No. 12064. 15 cts.

CORROSION.

Internal Corrosion in Boilers. Calls attention to the important influence of oxygen brought in with the water. 1600 w. Bos Jour of Com—April 24, 1897. No. 12316. 15 cts.

EFFICIENCY.

Test of the Cahall Boiler at the Armstrong Cork Works. Letter from Thomas Pray, Jr., replying to criticisms, with editorial remarks. 1800 w. Eng News—April 22, 1897. No. 12312. 15 cts.

EXPLOSION.

Steam Boiler Explosion at the Gratweiner Paper Mill. (Dampfkessel-Explosion in der Gratweiner Papier Fabrik.) An illustrated account of a destructive boiler explosion. The boiler was one of a battery of the Dupuis type, the rupture taking place along a newly riveted seam. 3000 w. and 1 plate. Oesterr Monatschr f. d. Oeffent Baudienst—March, 1897. No. 12420. 45 cts.

FEED-WATERS.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. A consideration of the various methods for the removal or treatment of scale producing substances. Third paper. 6200 w. Eng Mag—May, 1897. No. 12585. 30 cts.

High Feed-Water Temperatures A. L. McClurg. Extract from a recent lecture before the Massachusetts Assn., treating of exhaust heaters and their value. 1300 w. Bos Jour of Com—May 1, 1897. No. 12593. 15 cts.

GRATE Area.

Ratio of Heating Surface, Grate Area, and Cylinder Volume. Angus Sinclair. A table giving the leading particulars concerning 25 of the latest built locomotives, with discussion of the proportions which produce the most economical locomotive for different kinds of service. 2300 w. Loc Eng—April, 1897. No. 12085. 30 cts.

HIGH Pressures.

See same title under Marine Engineering.

STEAM.

Economic Steam Raising and Utilization. Arthur Heischmann. A discussion of the questions affecting the efficency of boilers and engines, the systems in use, and the advantages of superheated steam. 2800 w. Mach, N. Y—May, 1897. No. 12574. 15 cts.

WATER-TUBE Boilers.

See same title under Marine Engineering.

COMPRESSED AIR.

AIR-LIFT Pump.

Theoretical and Practical Limitations of the Air Lift Pump. E. E. Johnson. Explains the operation and the conditions under which the air is discharged. 1200 w. Eng News—April 22, 1897. No. 12311. 15 cts.

FLUID Air.

Fluid Air for Industrial Uses. Describes methods of liquefying air, and some of the uses. 700 w. Cons Repts—May, 1897. No. 12526. 45 cts.

RAILWAY Service.

See title "Compressed Air" under Railroad affairs, Miscellany, and Street and Electric Railways.

TOOLS.

Machine Tools Operated by Means of Compressed Air. Describes in detail a device in use on planing machines, the invention of Mr. Alexander Gordon, of Hamilton, O. Sectional views. 1000 w. R R Gaz—April 30, 1897. No. 12538. 15 cts.

POWER-TRANSMISSION.

Long Distance Transmission of Power. W. O. Amsler. Information regarding the use of compressed air for this purpose. 3500 w. Sib Jour of Engng—April, 1897. No. 12297. 30 cts.

ENGINES AND MOTORS.

ENGINE.

The Littlejohn Perfectly Balanced Engine. Illustrated description. 2000 w. Am Ship—April 15, 1897. No. 12214. 15 cts.

See also same title under Marine Engineering.

EXPERIMENTS.

Steam Engine Experiments. Bryan Donkin. Results of seven steam-engine experiments. A brief summary of the trials. 800 w. Engng—April 9, 1897. No. 12224. 30 cts.

EXPLOSION Motors.

Explosion Engines at the Budapest Exhibition. (Die Explosionsmaschinen auf der Millenniums-Landesausstellung in Budapest 1896.) Illustrating a great variety of recent gas and petroleum motors. 5000 w. Zeitschr d. Vereines deutscher Ingenieure—March 27, 1897. No. 12408. 30 cts.

GAS Engines.

Experiments on the Combustion of Lighting Gas in Gas Engines. Describes the experiments

made and gives results. 2200 w. Prac Eng—April 16, 1897. No. 12355. 30 cts.

Care of Gas Engines. Extracts from a work by Mr. Hiscox, giving practical suggestions. 1100 w. Bos Jour of Com—May 1, 1897. No. 12594. 15 cts.

Some Possibilities of Power Generation by Gas Engines and the Utilization of Rejected Heat. Reid T. Stewart. Abstract of paper read before the Eng's Soc. of W. Penna., with editorial comment. The writer shows that 75% of the total heat is discarded and suggests ways of utilizing this heat. 4500 w. Am Eng & R R Jour—May, 1897. No. 12520. 30 cts.

The Olin Gas and Gasoline Engine. Illustrated description of an engine of the single-acting four-cycle type. 1000 w. Eng News—April 15, 1897. No. 12208. 15 cts.

PISTON Packing.

Piston Packing. F. F. Hemenway. Reviews the progress of piston packing, and the different materials used. Ill. 1300 w. Mach, N. Y.—May, 1897. No. 12572. 15 cts.

REGULATION of Steam Engines.

The Determination of the Degree of Irregularity of Steam Engines. (Ermittlung des Ungleichförmigkeitsgrades von Dampfmaschinen.) A method of computing the degree of inequality in the forces acting in a given engine to enable the proper weight of fly wheel to be computed. 3500 w. Zeitsch d. Oesterr Ing u. Arch Vereines—March 12, 1897. No. 12412. 30 cts.

ROTARY Engine.

The Principles and Development of the Rotary Engine. Elmer S. Farwell. Reviewing the attempts to supersede the reciprocating engine. 2800 w. Eng Mag—May, 1897. No. 12587. 30 cts.

SERIES Engine.

The Wellington Series Engine. An Entirely New System of Developing Power from Heat. A description of the principal features of a new form of heat engine which promises to effect remarkable results. With editorial. 5500 w. Eng News—April 8, 1897. No. 12137. 15 cts.

STEAM ENGINES.

Steam Engines at the Swiss National Exposition at Geneva, 1896. (Schweizerische Nationalausstellung in Genf. 1896. Die Dampfmaschinen). Describes and illustrates engines by the leading builders of Switzerland, including compound and triple expansion stationary, and lake steamer engines. 2500 w. and 2 plates. Zeitschr d. Vereines deutscher Ingenieure—March 6, 1897. No. 12401. 30 cts.

The Accelerity Diagram of the Steam Engine. J. Macfarlane Gray. Read at session of the Inst. of Naval Arch'ts. Explanation of method, with diagrams. 1800 w. Ind & Ir—April 15, 1897. No. 12345. 30 cts.

The Carels High-Speed Steam Engine. (Machine à Vapeur à Grand Vitesse, Système Carels.) A compound single-acting engine with two sets of cylinders, with rotary valves, the whole encased after the manner of the Westinghouse engine. 2000 w. La Revue Technique—March 25, 1897. No. 12426. 45 cents.

SWISS Engines.

The Steam Engines at the Geneva Exposition. (Die Dampfmaschinen an der Schweiz. Landesausstellung in Genf. 1896.) With illustrations of compound engines and air compressor by leading Swiss builders. Two articles. 5000 w. Schweizerische Bauzeitung—March 20 & 27, 1897. No. 12409. 30 cts.

VALVE-GEARS.

See same title under Marine Engineering.

POWER AND TRANSMISSION.

COMPRESSED Air.

See title "Power Transmission" under Mechanical Engineering, Compressed Air.

ELECTRICAL Transmission.

See title "Power Transmission" under Electrical Engineering, Power.

EXPOSITION.

Power Exhibits at the Nuremberg Exposition (Die Kraftmaschinen auf der II bayerischen Landesausstellung in Nürenberg.) With illustrations of double deck boilers and a variety of engines by leading German builders. Two articles, and plates, 10000 w. Zeitsch d. Vereines deutscher Ingenieure—March 20 & 27, 1897. No. 12405. 30 cts.

POWER.

The Power Problem. J. C. Ranson. A consideration of the available sources of motive power, including steam, electricity, forces of nature, compressed air, and the gas engine. 2500 w. Tradesman—May 1, 1897. No. 12577. 15 cts.

SHOP AND FOUNDRY.

BICYCLES.

Magnetic Chucks for Bicycle Work. Illustrated description of a device intended especially for chucking bicycle parts such as cups, cones, etc., while being ground after hardening. 500 w. Am Mach—April 29, 1897. No. 12546. 15 cts.

CASTING.

The Uehling Pig-Iron Casting Machine. Illustrated description of a machine invented by E. A. Uehling, which has stood the test of practical experience. 1100 w. Ir Age—April 22, 1897. No. 12300. 15 cts.

Hints on Castings Direct from the Blast-Furnace. W. H. Butlin. An investigation of some of the forces present in the production of castings run direct from the blast-furnace. 1600 w. Ir & Coal Trds Rev—April 2, 1897. No. 12154. 30 cts.

A New Method of Casting Pig-Iron. Illustrated description of a new apparatus recently designed by Edward A. Uehling, for casting and conveying pig iron at blast-furnaces. 1400 w. Eng News—April 29, 1897. No. 12530. 15 cts.

DRILLING.

Horizontal Drilling Machines. John Randol. Comments on the excellent work done by this tool and the causes of its rarity, with illustrated description of several machines. 1700 w. Am Mach—April 15, 1897. No. 12254. 15 cts.

ELECTRIC Power.

Recent Practice in the Application of Electricity to Engineering Tools. F. J. Rowan. Read before the Inst. of Engs. and Shipbuilders. Illustrations with a short record of results obtained with electro-magnetic machine tools. 1200

w. Ir & Coal Trd Rev—April 2, 1897. No. 12155. 30 cts.

GEARS.

Eccentric Gears. Frank Richards. Results of investigations of eccentric gears as employed for the quick return service. Diagram. 2000 w. Am Mach—April 22, 1897. No. 12294. 15 cts.

Gear Arm Proportions. Henry Hess. Formula and diagrams, with description of method. 1100 w. Am Mach—April 29, 1897. No. 12544. 15 cts.

On the Machine-Cutting of Accurate Bevel and Worm Gears. J. H. Gibson. Read before the Inst. of North-East Coast of Engs. & Shipbuilders. A brief illustrated description of two machines from the writer's designs, which have been satisfactorily worked for over a year, with notes on machine-cut gearing generally. 5400 w. Ind & Ir—March 26, and April 2, 1897. No. 12213. 30 cts.

KEY-FITTING.

Different Ways of Fitting a Key. John Randol. Illustrates and describes the process of fitting a key. 1200 w. Am Mach—April 29, 1897. No. 12543. 15 cts.

FOUNDRY.

Progress in the Iron Foundry. Dr. R. Moldenke. Read before the Pittsburg Foundrymen's Assn. Discusses scientific methods, cupola practice, power, equipment, cast sheets, and the iron. The subject is treated more from the engineering standpoint than from the chemical. 4800 w. Ir Trd Rev—April 29, 1897. No. 12532. 15 cts.

SCREW MACHINE.

The Spencer Double-Turret Automatic Screw Machine. Illustrated description. 1500 w. Am Mach—April 22, 1897. No. 12295. 15 cts.

STRESSES.

Safe Stresses for Stationary English Main-Shafts and Crosshead-pins as Deduced from the Records of Experience. Henry Hess. Records of experience giving data on the failures of various parts, with deductions. 600 w. Am Mach—April 8, 1897. No. 12119. 15. cts

TOOLS.

Pattern-Making Bench Tools. John M. Richardson. Confined to those tools which the workman can own. 2500 w. Am Mach—April 8, 1897. No. 12118. 15 cts.

See also Railroad Affairs, Maintenance of Equipment, for items relating to shop-work.

MISCELLANY.

AERONAUTICS.

Aeronautics in 1896. (Die Aëronautik im Jahre 1896.) A review of the progress made during the past year, with especial reference to Continental Europe. 3000 w. Zeitschr d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12416. 30 cts.

BEAMS.

The Design of Beams. W. H. Atherton. Part first deals with engine beams, gun beams, cranes, bridge girders, shafts and sundry examples. Ill. 1700 w. Mech Wld—April 16, 1897. No. 12374. 30 cts.

BEARINGS.

Concerning Glass Machinery Bearings. F. A. Farnsworth. Illustrated description of experiments made. 1000 w. Ir Age—April 29, 1897. No. 12386. 15 cts.

CAM.

Pattern for a Cylinder Cam. John M. Richardson. Describes a cam for converting a rotary motion into a reciprocating one (within certain limits), and usually in a horizontal direction. Ill. 1300 w. Mach, N. Y.—May, 1897. No. 12571. 15 cts.

COLD.

Machine for the Production of Very Low Temperatures. (Machine zur Erzielung nildrigster Temperaturen, &c.) A communication by Prof. Linde of Munich, giving a full account of his apparatus for producing temperatures below —140° C. and for liquefaction of air. Two articles. 6000 w. Glaser's Annalen—March 15 & April 1, 1897. No. 12433. 30 cts. each.

CONDENSATION and Insulation.

Condensation in Steam Pipes and Insulating Materials. Dr. John Russner. Translated from Wochenblatt für Papierfabrikation. A study of the loss of heat from radiation and conduction, and the value of insulation. 2200 w. Power—May, 1897. No. 12559. 15 cts.

CYLINDERS.

Strength of Thick Hollow Cylinders. John H. Cooper. The work and results of many well-known writers arranged to exhibit the practical quality necessary to have if work is to be done. 2300 w. Prac Eng—March 26, 1897. No. 12065. 30 cts.

EDUCATION.

Industrial Education. George W. Dickie. The writer's experience of the kind of preparation necessary to fit one to fill an honorable place in the industrial army. Also discussion. 9000 w. Jour Assn of Engng Soc—March, 1897. No. 12512. 30 cts.

EXCAVATING.

The Calhoun Excavating and Conveying Machine. Illustrated description of a cableway device which has been used extensively in handling gravel, coal, and similar materials, and is now being built for sewer and ditch work. 1400 w. Eng News—April 15, 1897. No. 12205. 15 cts.

FORCING FITS.

Allowance for Forcing Fits. Reviews the prevailing practice as gathered from different makers, with tabulated statements. 1900 w. Mach, N. Y.—May, 1897. No. 12575. 15 cts.

INTERPOLATION.

Formulæ of Interpolation. Explains the Lagrange method of interpolation, as most generally applicable. 1400 w. Engng—March 26, 1897. No. 12068. 30 cts.

KITES.

I. Scientific Kite-Flying. J. B. Millett. II. Experiments with Kites. Hugh D. Wise. III. Photographing from Kites. William A. Eddy. Three illustrated articles. The first has special reference to the Blue Hill experiments; the second includes an account of the writer's ascent from Governor's Is.; the third includes accounts of the first photographing and

the first telephoning and telegraphing through a line held by kites. 12800 w. Cent Mag—May, 1897. No. 12518. 45 cts.

LUBRICANTS.

Notes on Liquid Lubricants. Henry E. Cutts. Some points on the selection of oils and their application. 1200 w. Marine Engng—April, 1897. No. 12108. 30 cts.

MACHINE Design.

Some Barriers to Progress in Machine Design. Charles Hotchkiss. A talk about designers and their relations to the business and the office of the work in which they may be engaged. 2500 w. Am Mach—April 29, 1897. No. 12545. 15 cts.

RUBBER Substitutes.

The Manufacture of Rubber Substitutes. Explains the term, and briefly considers the best known substitutes. 1100 w. Ind Rub Wld—April 10, 1897. No. 12384. 45 cts.

STRAINS.

On the Changes Produced in Soft Metals by Permanent Strain. Albert Campbell. Results of experiments to determine to what extent the properties of soft wires are affected by permanent strain, carried out on materials of widely different constitution. 2500 w. Engng—April 9, 1897. No 12226. 30 cts.

SUPERHEATER.

The Hering Steam Superheater. (Die Hering'schen Dampfüberhitzer.) Illustrated description of an improved apparatus giving better control over the temperature, and avoiding overheating. 2000 w. Oesterr Zeitschr f. Berg u. Hüttenwesen—Feb. 27, 1897. No. 12484. 30 cts.

TIE-RODS.

On the Arrangement and Computation of Tie-Rods in Condensers. Rudolph Leupold. The purpose of the article is to provide a rule for bracing by means of tie-rods, based on the principles of hydrostatics. 800 w. Pro Age—May 1, 1897. No. 12560. 15 cts.

TIRES.

Pneumatic Tires. Editorial discussion of rubber used, and processes it has to undergo before coming out as a finished tire. 1500 w. Engng—April 16, 1897. No. 12351. 30 cts.

WEIGHING Machine.

A Power-Feed, Automatic Weighing Machine. Illustrated description of a machine made by the Pratt & Whitney Co. of Hartford, Conn., and designed by Francis H. Richards. 2300 w. R R Gaz—April 16, 1897. No. 12210. 15 cts.

WIRE.

Wire. A. L. Orton. Methods of manufacture and the effect upon strength, conductivity, &c. 1800 w. Sib Jour of Engng—April, 1897. No. 12298. 30 cts.

MINING AND METALLURGY.

COAL AND COKE.

AYRSHIRE.

The Ayrshire Coalfield. M. E. The geology, method of working, ventilation, pumping, boilers, screening, &c. 1500 w. Col Guard—April 15, 1897. No. 12332. 30 cts.

BRIQUETTES.

The Briquette Works of the Senftenberg Soft Coal District. (Der Brikettfabriken des Senftenberger Braunkohlenreviers.) Report of a trip of investigation made by Prof. Scheele, and dealing mainly with the question of dust explosions in the course of the manufacture of coal briquettes. Two articles. 3500 w. Glückauf—March 13, 20, 1897. No. 12485. 30 cts. each.

Dust Explosions in Briquette Works and Means for Their Prevention. A. Scheele. From notes of a visit to the briquette factories of the Senftenberg lignite district. Concludes that collecting chambers are not necessary, discusses means of getting rid of the dust, &c. 4000 w. Col Guard—April 15, 1897. No. 12330. 30 cts.

COAL.

Ohio Coal and the Railroads. Editorial on the importance of the Ohio coal field from the railroad point of view, the present condition of the industry. 1400 w. R R Gaz—April 16, 1897. No. 12212. 15 cts.

COAL GETTING.

Coal-Getting by Machinery. Charles Latham. Report of lecture at the University College, Nottingham. Discusses the effect upon labor, number employed, wages, safety, &c. 1600 w. Col Guard—April 15, 1897. No. 12333. 30 cts.

COLORADO.

The Newcastle Mines. R. M. Hosea. One of the Colorado Fuel and Iron Co.'s most extensive coal mining plants is described and illustrated. The peculiar geological features of the coal measures, methods of working, drainage, ventilation, &c. 7200 w. Col Eng—April, 1897. Serial. 1st part. No. 12271. 30 cts.

EXPLOSIONS.

Saving Life in Colliery Explosions. Ernest J. Bailey. The writer's suggestions to meet life-saving requirements from afterdamp after explosions. A scheme for supplying fresh air by means of a compressed air plant. 1800 w. Col Guard—April 9, 1897. No. 12256. 30 cts.

FIREDAMP.

Contributions to the Firedamp Question (Beiträge zur Schlagwetterfrage.) An elaborate review of Behren's treatise, giving data relating especially to the coal mines of Austro-Hungary. Three articles, 8000 w. Oesterr. Zeitschr für Berg u. Hüttenwesen—Jan. 23, 30, Feb. 6, 1897. No. 12480. 30 cts. each.

HOCKING Valley.

Job's Mine, in the Hocking Valley, Ohio. Illustrates and describes the machines in use at this mine, which is one of the largest producers of bituminous coal in the United States. 800 w. Eng & Min Jour—April 17, 1897. No. 12263. 15 cts.

INCLINE.

New Arrangements of Brake Incline. From communications by Bergassessor Stens of Essen-an-der Ruhr, to Glückauf. The method of haulage is described and its advantages and dis-

advantages noted. Ill. 1800 w. Col Guard—April 2, 1897. No. 12164. 30 cts.

MINERAL Seams.

The Mineral Seams of New Monkland, Lanarkshire. James Prentice. Abstract of a paper read before the Mining Inst. of Scotland. Description of the seams which have been or are being worked, from which in recent years upwards to 1½ million tons annually have been raised. 3000 w. Col Guard—April 2, 1897. No. 12166. 30 cts.

MINING.

Steam, Compressed Air, and Electricity for Haulage, Coal-Cutting, &c. Ernest Kilburn Scott. Essay submitted in competition for special prize. A few of the points which should receive consideration when deciding what system of working is likely to give the greatest economy and the maximum amount of convenience. 3800 w. Ir & Coal Trds Rev—April 2, 1897. Serial. 1st part. No. 12153. 15 cts.

SOUTH AFRICA.

South African Coal. The steady development of coal-mining in the Cape of Good Hope and Natal as shown in the history of coal for the railways. 2000 w. Engng—April 9, 1897. No. 12225. 30 cts.

THIN Seams.

The winning of Thin Flat Coal Seams. (Abbau minder machtiger flachliegender Flotze.) Describing a system of long wall mining to obtain the coal with a minimum of waste. 3000 w. & 1 plate. Oesterr Zeitschr f. Berg. u. Hüttenwesen—Jan. 30, 1897. No. 12479. 30 cts.

WAGES.

Wages in the Coal Mining Industry during 1895. From the third annual report on changes in wages and hours of labor in the United Kingdom during 1895, by H. Llewellyn Smith of the Labor Dept. of the Board of Trade. 1200 w. Col. Guard—March 26, 1897. No. 12081. 30 cts.

COPPER.

COPPER Minerals.

The Occurrence of Copper Minerals in Hematite Ore, Montana Mine, Soudan, Minnesota. Part I. is a description of the occurrence, by J. H. Eby; and part II., a study of the minerals, by Charles P. Berkey. 5000 w. Pro L Sup Min Inst—Aug., 1896. No. 12505. 45 cts.

MICHIGAN.

Machinery of the Copper Mines of Michigan. Charles P. Paulding. Illustrated description. 1800 w. Am Mach—April 8, 1897. No. 12117. 15 cts.

GOLD AND SILVER.

AMALGAMATION.

Theories of Pan Amalgamation. E. Herligendorfer. Discovers the reason why raw pan amalgamation can never recover all the silver from sulphurets. 900 w. Min & Sci Pr—April 24, 1897. No. 12387. 15 cts.

CYANIDE PROCESS.

The Cyanide Process of Gold Extraction. An illustrated description of the nature of the process, its chemical principles, &c. 2200 w. Eng, Lond—April 16, 1897. Serial. 1st part. No. 12325. 30 cts.

EAST INDIES.

Gold in the Dutch East Indies. Reinier Verbeek. An interesting letter full of information of the conditions, people, climate, mines, &c. 2400 w. Eng & Min Jour—April 17, 1897. No. 12262. 15 cts.

GOLD.

Gold from the Sea and River. Discusses the probability of gold existing in this quarter, and the chemist's explanation of how it gets there. 1100 w. Mach—April 15, 1897. No. 12354. 30 cts.

GRAVEL DEPOSITS.

The Marble Belt. A. Thurston Heydon. A region of interest to miners because of the large deposits of rich gravel. Reviews the formation, character and past work. 1000 w. Min & Sci Pr—April 10, 1897. No. 12269. 15 cts.

MASHONALAND.

Notes on the Umtali District (Manica Mashonaland) (Ein Beitrag zur Keuntniss deo Umtaii Districts) (Manica Mashonaland) Geological notes on the Mashonaland gold district, with map and sections. 2500 w. and map. Oesterr Zeitschr f Berg u. Hüttenwesen—Jan. 2, 1897. No. 12477. 30 cts.

MILLING.

Some Notes on the Milling of Gold Ores. John E. Hardman. Outlines the most prominent conditions of ores met with in practice, and discusses the selecting of the process for milling and its importance, the design of the plant, &c. 4000 w. Can Min Rev—April, 1897. No. 12567. 30 cts.

NEW GUINEA.

The Gold Rush to British New Guinea. Theodore F. Bevan. A lecture delivered in Melbourne is reported, with the discussion that followed. 3000 w. Aust Min Stand—Feb. 18, 1897. No. 12146. 30 cts.

ONTARIO.

The Western Ontario Gold Fields and their Genesis. F. Hills. Considers the Bad Vermilion Lake and the Saw Bill Lake deposits, describing the formation and process of deposition. Ill. 5000 w. Can Min Rev—April, 1897. No. 12565. 30 cts.

PYRITIC Gold Ores.

Practical Treatment of Pyritic Gold Ores at Gibbonsville, Idaho. A detailed sketch of the reduction plant, and the methods of treatment employed therein. 3500 w. Min & Sci Pr—April 3, 1897. No. 12131. 15 cts.

SAN JUAN.

A Second Visit to the San Juan, Colorado, Region After Three Years' Absence. Arthur Lakes. Describes the crossing of San Luis park, recent eruptions of lava, great coal fields, visits to prominent ore mines, &c. 6800 w. Col Eng—April 1897. No. 12272. 30 cts.

SEPARATION.

Separation of Gold and Silver from Low-Grade Bullion. F. Gutzkow. Describes the writer's process of parting doré silver as adapted to the treatment of coppery silver bullion. 1700 w. Eng & Min Jour—April 17, 1897. No. 12264. 15 cts.

SIBERIA.

Gold Mining in Siberia. Russell L. Dunn. Gives conclusions from a study of Siberian mines and mining conditions on the ground, explaining methods of prospecting, exploration, &c.

Ill. 3000 w. Min & Sci Pr—April 3, 1897. No. 12130. 15 cts.

SOUTHERN UNITED STATES.

The Southern Gold Belt. William M. Bowron. The Gold mining in the South, with description of modern practice at the Royal gold-mine, Tallapoosa, Ga. Ill. 4000 w. Tradesman—May 1, 1897. No. 12576. 15 cts.

SULPHIDE Ores.

Silver-Lead-Zinc Sulphide Ores. J. T. Greenbury. Describes operations which represent very nearly what has been accomplished on a practical scale in connection with the treatment of the Broken Hill sulphide ores. 3000 w. Aust Min Stand—Jan. 20, 1897. No. 11626. 60 cts.

TAILINGS.

The Treatment of Tailings by the Cyanide Process. John Yates. A comparison of the zinc and electrical methods, with a short description of the plant and appliances required in each. 1900 w. Aust Min Stand—March 11, 1897. Serial. 1st part. No. 12181. 30 cts.

VICTORIA.

The Alluvial Leads of Victoria. Plan of these leads from the source to the present workings, with tabulated statement giving some idea of the metal won. 500 w. Aust Min Stand—Feb. 25, 1897. No. 12156. 30 cts.

YUKON District.

Gold Mining in the Yukon District. W. M. Ogilvie. Detailed description of the different methods of gold mining used, with information in regard to the various routes by which one may arrive at these gold fields, and points of interest to miners. 4400 w. Can Min Rev—April, 1897. No. 12569. 30 cts.

IRON AND STEEL.

ARMOR PLATE.

Trial of Side and Deck Armor for the United States Battleships Kearsarge and Kentucky. Engraving of test plate with particulars of test. 700 w. Sci Am—May 1, 1897. No. 12388. 15 cts.

Tests of Armor Plates at the Witkowitz Iron Works. (Schiessversuche gegen Panzerplatten im Eisenwerke Witkowitz.) Comparative tests of Harveyized and nickel-steel plates, both showing good results, rather favoring the latter. 2000 w. Stahl und Eisen—April 1, 1897. No. 12439. 30 cts.

The Armor Plate Imbroglio. W. L. C. A statement of the situation, with letters from the Illinois Steel Co., the Carnegie Steel Co., and the Bethlehem Iron Co., with suggestions from Secretary Long. 3800 w. Ir Age—April 15, 1897. No. 12199. 15 cts.

BIRMINGHAM, Alabama.

Notes on the Birmingham District. John S. Kennedy. Information as to improved practice and low cost of production. 2300 w. Ir Age—April 22, 1897. Serial. 1st part. No. 12299. 15 cts.

The Tennessee Company's Properties. A number of views and brief description of representative furnace plants and iron ore mines of the Birmingham district. 800 w. Ir Trd Rev—April 1, 1897. No. 12094. 15 cts.

BLAST Furnace.

American and British Blast-Furnace Practice. J. Stephen Jeans. Showing comparative labor costs in the United States and Europe. Second paper. 4400 w. Eng Mag—May, 1897. No. 12581. 30 cts.

CASTING.

See same title under Mechanical Engineering, Shop and Foundry.

CONCENTRATION.

The Magnetic Concentration of Iron Ores. (Elektromagnetische Aufbereitung der Eisenerze.) A general review of the progress made in Germany and America. 3500 w. Stahl und Eisen—March 15, 1897. No. 12436. 30 cts.

The Wetherell Magnetic Concentrating Process. H. B. C. Nitze. A process for separating various mineral and chemical substances, of such feeble magnetic permeability, that they have been heretofore generally considered as non-magnetic, from one another and from such accompaniments as are absolutely inert, by means of powerful and specially-devised electro-magnets. Ill. 3800 w. Jour Fr Inst—April, 1897. No. 12113. 45 cts.

DUQUESNE.

The Duquesne Furnaces of the Carnegie Steel Company, Limited. Illustrated interesting description of this new furnace plant. 3500 w. Ry Rev—April 3, 1897. No. 12079. 15 cts.

ELASTICITY.

Elasticity and Fatigue. H. K. Landis. Part first deals only with elasticity of steel, considering the elastic factors, methods of testing, drop of beam, permanent set, proportionality, comparison of limits and dynamic elasticity. 4200 w. Am Eng & R R Jour—May, 1897. Serial. 1st part. No. 12521. 30 cts.

HYDRAULIC PRESS.

The Steam Hydraulic Press as a Substitute for the Blooming Hammer. (Ersatz der Luppenhämmer durch dampf-hydraulische Pressen.) Description and illustration of combined steam and hydraulic press for handling blooms, instead of the steam hammer. 2500 w. Stahl und Eisen—April 1, 1897. No. 12438. 30 cts.

IRON Industry in India.

The Practicability of Establishing an Iron Industry at or near Salem (India). Comment on paper on this subject by Jeremiah Head. The report deals exhaustively with the subject and gives conclusions which finally pronounce the opinion that the work is not at present practicable. These conclusions are examined. 3000 w. Ind Engng—March 13, 1897. No. 12201. 45 cts.

IRON Range.

The Marquette Iron Range of Michigan. George A. Newett. Description of the district and mines, with map. Ill. 7700 w. Pro L Sup Min Inst—Aug., 1896. No. 12506. 45 cts.

NICKEL STEEL.

Nickel-Steel as an Improved Material for Boiler Shell Plates, Forgings, and Other Purposes. William Beardmore. Paper read before Inst. of Naval Archts. Showing reasons why, in the writer's opinion, nickel-steel is a most suitable material with which to meet the de-

mands for a metal stronger than steel. Ill. 2500 w. Ind & Iron—April 15, 1897. No. 12344. 30 cts.

The Expansion of Nickel-Steel. (Sur ladilatation des aciers au nickel.) A communication to the Académie des Sciences by M. Guillaume, giving coefficients of expansion for a number of different alloys of steel and nickel. 1000 w. Moniteur Industrielle—Feb. 13, 1897. No. 12490. 30 cts.

OPEN HEARTH.

The Bertrand Thiel Open Hearth Process. Joseph Hartshorne. Comments on the paper of P. C. Gilchrist on the above named process, with its discussion, with report on the work which is being done at present. 3500 w. Ir Age —April 15, 1897. No. 12197. 15 cts.

SAMPLING.

Methods of Sampling Iron Ore. C. T. Mixer. Presents the schemes adopted at some mines in Marquette County, to separate properly their various ores, with remarks on the occurrence of the iron and phosphorus in some of the deposits. 2300 w. Pro L Sup Min Inst—Aug., 1896. No. 12502. 45 cts.

STEEL.

Some Recent Views of Bridge and Boiler Steel. J. C. Some details of the present trend of thought and practice among American engineers. 1000 w. Ir & Coal Trds Rev—April 16, 1897. No. 12370. 30 cts.

Steel Processes. B. F. Spalding. Brief discussion of new processes, and opinions of metallurgists. 2800 w. Prac Eng—March 26, 1897. No. 12066. 30 cts.

STEEL Construction.

See same title under Architecture and Building, Construction and Design.

SULPHUR.

The Occurrence of Sulphur in Iron. Its Introduction and Removal. E. L. Rhead. Read before the West of Scotland Iron and Steel Inst. The paper proposes to deal mainly with a mass of evidence accumulated by many workers, and as far as possible reduce it to order. 2200 w. Am Mfr & Ir Wld—April 2, 1897. Serial. 1st part. No. 12083. 15 cts.

MINING.

BRACING.

Comparative Tests of Bracing for Wooden Bents. Edgar Kidwell. Describes a series of experiments made to obtain data as to the relative value of the different forms of bracing with conclusions Ill. 5000 w. Pro L Sup Min Inst—Aug., 1896. No. 12503. 45 cts.

CO-OWNERSHIP.

The Law as to the Co-ownership of Mining Property. Discusses the subject from the English point of view. 2300 w. Col Guard—April 15, 1897. No. 12334. 30 cts.

FREEZING.

Sinking Shafts by Freezing Process. (Fonçage des Puits de Mine par Congélation.) Describes the natural process, the Poetsch system as used in France, also the systems of Gobert and Koch, and the cold air method of Lindmarck, used in Sweden. 3000 w. 1 plate. La Revue Technique—March 25, 1897. No. 12425. 45 cts.

HAULAGE.

I. Electric Mine Haulage Plant. E. F. Bradt. II. Underground Electric Haulage Plant. James E. Jopling. The first paper describes the plant of the Pittsburg and Lake Angeline Iron Co., Mich., and the second the plant in the Cleveland Lake Mine, Ishpeming, Mich., with discussion of both papers. 4000 w. Pro L Sup Min Inst—Aug., 1896. No. 12501. 45 cts.

HYDRAULIC Mining.

Practical Notes on Hydraulic Mining. George H. Evans. Part first names points on which a mine manager should be thoroughly posted, and considers water facilities, and nature of the country for grades, etc., as the first two. 2000 w. Min & Sci Pr—April 10, 1897. Serial. 1st part. No. 12268. 15 cts.

HOISTS.

Electric Hoists for Mines. Illustrated description of several hoists which have have been in constant service for months. 1000 w. Ir Trd Rev—April 1, 1897. No. 12095. 15 cts.

MINE Shots.

Electric Ignition of Mine Shots. Bergassessor Heise. From a report in "Glückauf," of a lecture to the Assn. of Technical Mine Managers for the Dortmund District. Discusses heat ignition, spark ignition, safety in firedamp, &c. 1600 w. Col Guard—March 20, 1897. No. 12082. 30 cts.

MINING Machinery.

A Few Notes on Material used in Mining Machinery. H. W. De Courteney. Dissects the stamp mill into its principal parts, and discusses the metal which is best suited to each part. The various qualities of iron and steel as adapted to the use. 3800 w. Can Min Rev—April, 1897. No. 12568. 30 cts.

PACIFIC Coast.

Electricity in Mining on the Pacific Coast. F. A. C. Perrine. Statements showing the unsuitability of electrical mining apparatus to the particular conditions of the mines on the Pacific slope. 1400 w. Elec Engng—April 15, 1897. No. 12232. 15 cts.

PETROLEUM.

The Petroleum Industry in Russia. (Die Erdölindustrie in Russland.) A general review of the official Russian report made for the Nijni-Novgorod Exposition, giving data from 1882 to 1895 inclusive; chiefly statistical. Two articles. 7000 w. Oesterr-Zeitschr f. Berg u. Hüttenwesen—Jan. 16–23, 1897. No. 12478. 30 cts. each.

PUMPS.

Mine Pumps. Philip R. Bjorling. Part first consists of introductory remarks and a description of the action of an ordinary bucket pump. Ill. 600 w. Mech Wld—March 26, 1897. Serial. 1st part. No. 12057. 30 cts.

STEAM SHOVEL.

The Steam Shovel in Mining. A. W. Robinson. Considers briefly the design and construction of the steam shovel, and the considerations which should govern the selection of a shovel to suit the work of the mining regions. 3800 w. Pro L Sup Min Inst—Aug., 1896. No. 12504. 45 cts.

WINDING.

New Winding Arrangment with Constant Resistance. André Després. Describes a new method whose object is to afford an absolutely constant movement with a single chain, to permit of employing the lightest possible chain, to afford a high degree of safety, &c. 2400 w. Col Guard—April 9, 1897. No. 12257. 30 cts.

MISCELLANY.

ALLOYS.

Alloys. Prof. Roberts-Austen. Report of second Cantor lecture on this subject. 1200 w. Engng—March 26, 1897. No. 12071. 30 cts.

Alloys. Prof. Roberts-Austen. Report of his third Cantor lecture on this subject. 900 w. Engng—April 2, 1897. No. 12162. 30 cts.

Alloys. Prof. Roberts-Austen. Report of the fourth and concluding Cantor lecture on this subject, taking up the discussion of curves of initial freezing points. 600 w. Engng—April 9, 1897. No. 12229. 30 cts.

ALUMINUM.

Aluminum and Its Use in the Foundry. Joseph Allison Steinmetz. General advantages claimed with general conclusions. 2000 w. Ir Age—April 15, 1897. No. 12198. 15 cts.

Aluminum: Its Present and Future. Part first reviews early investigation of this metal, and the processes used. 2500 w. Eng, Lond—April 2, 1897. No. 12148. 30 cts.

The Working of Sheet Aluminum. From "The Aluminum World" The great secret is said to consist in the proper lubricant and the shape of the tool. Discusses lathe work, drawing, spinning, frosting and burnishing. 2300 w. Ir Age—April 29, 1897. No. 12385. 15 cts.

CARBON.

Contributions to the Investigation of the Crystallization of Carbon. (Beiträge zur Keuntnis der für die Krystallization des Kohlenstoffes Günstigen Bedingungen.) A paper by Dr. Borchers describing his own experiments with a special form of electric furnace, and indicating the lines on which further experiments should be continued. 3000 w. Zeitschr für Elektrochemie—March 20, 1897. No. 12452. 30 cts.

DIAMONDS.

The Diamond Mines of Kimberley. Dr. William Crookes. Two lectures delivered at the Imperial Inst. Interesting description of Kimberley, the mines, workings, &c. 6800 w. Nature—April 1, 1897. No. 12167. 30 cts.

EXPOSITION.

Notes from the Millennial Exposition. (Von der Millenniums-Landesausstellung.) Giving an account of the exhibits relating to the mining industry; chiefly mechanical. 1000 w. 1 plate. Oesterr Zeitschr f. Berg u. Hüttenwesen—Feb. 13, 1897. No. 12481. 30 cts.

GYPSUM.

Gypsum in Kansas. G. P. Grimsley. Early account of this mineral, and the location, geology, topography, &c., of the areas in this state. Ill. 4500 w. Kansas Univ Quar—Jan., 1897. No. 12127. 45 cts.

On the Chemical Composition of Some Kansas Gypsum Rocks. E. H. S. Bailey and W. M. Whitten. The results of analysis of average samples of the rock or dirt used at the mills. 1500 w. Kansas Univ Quar—Jan., 1897. No. 12128. 45 cts.

LEASE.

Specific Performance of Contracts for Lease of Mines. The essential facts of the decisions in the cases relating thereto which have come before the High and Appeal Courts of England for adjudication. Also a statement of the principles which guide these courts in directing and refusing specific performance of contracts 3000 w. Col Guard—April 2, 1897. No. 12165. 30 cts.

MICA.

A New Use for Scrap Mica. H. C. Mitchell. Read before the Ontario Min. Inst. Showing that this hitherto costly waste may become a valuable by-product. Describes its manufacture as an insulator of steam heat, its use for fireproofing, its use in resisting extreme cold, &c. 3000 w. Can Min Rev—April, 1897. No. 12566. 30 cts.

SALT.

The Müller Salt Press. (Ueber die Müller'sche Salzbriquettes-Presse.) An illustrated description of the apparatus used in Austria for compressing salt into "briquettes" for commercial convenience. Two articles and 1 plate. 6000 w. Oester Zeitschr f. Berg u. Hüttenwesen—March 13, 20, 1897. No. 12483. 30 cts. each.

THERMOPHONE.

Wiborgh's Thermophone. (J. Wiborgh's Thermophone.) The thermophone consists of an explosive pellet embedded in a cylinder of fire-clay. The time elapsing from the exposure to heat to the explosion is a measure of the temperature. 3500 w. Oesterr Zeitschr f. Berg. u. Hüttenwesen—Feb. 20, 1897. No. 12482. 30 cts.

TUYERES.

Making Tuyeres—Bronze or Copper. Phil. Pastre. Illustrated description. 800 w. Mach, N. Y.—May, 1897. No. 12573. 15 cts.

UTAH.

The Camp Floyd Mining District and the Mercur Mines, Utah. R. C. Gemmell. Part first gives the history and topography of this district, fifty miles south of Salt Lake City. Ill. 2000 w. Eng and Min Jour—April 24, 1897. Serial. 1st part. No. 12347. 15 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.

Acetylene and its Liability to Explosion. (Das Acetylen und Seine Explosions gefährlichkeit.) A paper by Dr. Slaby before the Society of Railway Engineers, showing that with reasonable care, explosions need not occur. 2000 w. Glaser's Annalen—April 1, 1897. No. 12434. 45 cts.

Acetylene on Board Ships. Vivian B. Lewes. Report of a lecture delivered before the Inst. of

Naval Arch'ts. Considers the uses to which it could be put, and the factor of danger. 1200 w. Gas Wld—April 10, 1897. No. 12252. 30 cts.

Acetylene Solution. (L'Acétylène Dissous) A proposition to dissolve acetylene gas in liquid acetone, the latter being obtained by calcination of acetate of lime. The gas in solution under pressure to be served to customers in siphons similar to those used for carbonated waters. 1000 w. La Revue Technique—March 25, 1897. No. 12430. 45 cts.

Further Communications on Acetylene. (Einige weitere Mittheilungen über Acetylen.) A paper and discussion by Inspector Leissner and others before the German Society of Mechanical Engineers, including the apparatus for the production of the carbide of calcium, and the reduction of cost and danger. 7500 w. Glaser's Annalen—March 15, 1897. No. 12431. 45 cts.

German Chemists Discuss Acetylene. Report of discussion of the Berlin Chemical Industrial Society. 1500 w. Gas Wld—April 3, 1897. No. 12160. 30 cts.

Letang & Serpollet's Acetylene Lamp. A. Etançon, in La Nature. Illustrated description of the lamp, manner of charging and cost of light. 1200 w. Sci Am Sup—May 1, 1897. No. 12400. 15 cts.

The Future of Acetylene. Interesting evidence given by Thomas Holliday, chemist and engineer, before a select committee of the House of Commons, in support of the Irish Industries Bill, and advocating Ireland as a center for this industry. 2200 w. Gas Wld—April 17, 1897. No. 12336. 30 cts.

EXTINGUISHING.

New System for the Instantaneous Lighting and Extinguishing of Gas Jets at Any Distance. Translated from Le Gaz, by Herman Poole. Explains the system devised jointly by Mr. Egraz, Doctor Guyenot, and Mr. Chateau. The power used is electricity. 2000 w. Am Gas Lgt Jour—April 26, 1897. No. 12342. 15 cts.

COAL GAS.

The Commercial Uses of Coal Gas. Thomas Fletcher. These notes are the result of more than thirty years' experience as to the practical working, results, advantages, and drawbacks, of coal-gas as a fuel. 3000 w. Gas Wld—April 8, 1897. No. 12159. 30 cts.

COST.

Some Notes of the Comparative Cost of Supplying Light by Gas and Electricity in Manchester. G. E. Stevenson. The question is confined to the cost of supply. In manufacturing, gas shows but little advantage over electricity, but in distribution there is a decided difference in favor of gas. 1800 w. Gas Eng's Mag—April 10, 1897. No. 12592. 30 cts.

GAS.

The Gas in Your House. Some useful things that the consumer ought to know. Burners, meters, variation of pressure, use of globes, &c. 2300 w. Dom Engng—April, 1897. No. 12368. 30 cts.

LEAKS.

The Detection of Leaks in Gas-Mains. Describes and approves the system of M. Bouvier, giving two examples where its use made a considerable saving. 2000 w. Jour Gas Lgt—April 6, 1897. No. 12253. 30 cts.

"MANJAK."

The Use of "Manjak" in the Manufacture of Coal Gas. Jos. Harger Pye. Remarks on the natural bituminous pitch which in the Barbados is known by the name of "Manjak." General characteristics and results obtained from its use. 1100 w. Jour Gas Lgt—April 20, 1897. No. 12525. 30 cts.

WATER GAS.

Prof. Lewes on Carburetted Water Gas. Report to Birkenhead with reference to the safety, or otherwise, of supplying a mixture of coal gas and carburetted water gas, and also as to the relative value of such a mixture as compared with coal gas of equal illuminating power. The present paper gives the experimental data and reasons upon which his conclusions are based. 2800 w. Gas Wld—April 17, 1897. No. 12335. 30 cts.

Observations on Carbureted Water Gas. J. T. Westcott. A paper prepared at the invitation of the Civil and Mechanical Engineers' Society of London, Eng. Gives the history, method of operation, analysis, cost, advantages, &c. 4800 w. Am. Gas Lgt Jour—April 12, 1897. No. 12182. 15 cts.

SEWERAGE.

DRAINAGE.

The Jourdan Avenue Drainage Station, New Orleans, La. Don Y. Dyer. The peculiar topography necessitated the raising of the surface drainage from receiving basins by the use of the pumps, over and outside the levees surrounding the city. The plant is described. 1100 w. Fire & Water—April 10, 1897. No. 12174. 15 cts.

SANITATION.

The Conversion of Discharges into Poudrette. (Die Verwandlung der Faeces in Poudrette.) A paper read by Dr. Vogel before the German Association for Sanitary Promotion, describing the chemical treatment by which night soil is converted into an inoffensive fertilizer. 3500 w. Gesundheits Ingenieur—March 15, 1897. No. 12447. 30 cts.

SEWAGE Plant.

The Sewage Disposal Plant at Central Falls, R. I. W. F. Keene. Illustrated description. 1000 w. Eng Rec—April 24, 1897. No. 12338. 15 cts.

SEWAGE Purification.

Purification of Sewage (Klärversuche). A discussion of the Permanganate and Ferozone-Polarite Systems of purifying sewage water. 4000 w. 1 plate. Gesundheits-Ingenieur—Jan. 15, 1897. No. 12449. 30 cts.

VENTILATION.

Sewer Ventilation. Report of the Sanitary Committee of Cardiff. A tabulated statement of replies received from various towns as to certain points in connection with the subject. 1300 w. Plumb & Dec—April 1, 1897. No. 12202. 30 cts.

STREETS AND PAVEMENTS.

ASPHALT.

Asphalt and Asphalt Pavements. George W.

Tillson. Describes asphalt from various localities, and its use for pavements, with the questions related. 8800 w. Pro Am Soc of Civ Engs—April, 1897. No. 12515. $1.00.

Origin and History of Asphalt. Bernard Bienenfeld. Reviews the ancient uses and enduring qualities of this substance, its chemical mixture, and the probable origin. 3400 w. Munic Engng—May, 1897. No. 12556. 30 cts.

STREET CLEANING.

The Street Cleaning of Berlin. (Das stadtische Strassenreinigungswesen Berlins.) An account of the methods and cost of cleaning the streets of Berlin, in which it is shown that the per capita cost is only one-sixth that of New York. 2000 w. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12445. 30 cts.

STREETS.

The Influence of Beautiful Streets upon Public Health. Considers the questions involved in modern street construction, and the numerous matters that must be provided for, and the importance of securing street engineers of true worth. 1100 w. San Rec—April 16, 1897. No. 12359. 30 cts.

WATER SUPPLY.

DISCHARGE Tunnels.

Discharge Tunnels from Reservoirs. James A. Paskin. Read before the British Assn. of Water-works Engs. at Nottingham. Consideration of important features in the construction of these outlets. 1600 w. Eng Rec—April 17, 1897. No. 12219. 15 cts.

ELECTRIC Pumps.

Waterworks with Electric Driving. (Wasserwerk mit elecktriktrischem Antrieb.) Illustrated description of the plant at Dillingen, Bavaria. A high-service system, the pressure being regulated by accumulators controlling the electric motors. The double-acting pumps have mechanically operated valves. 1500 w. Zeitsch d. Vereines deutscher Ingenieure—March 20, 1897. No. 12406. 30 cts.

FINANCES.

The Financial Management of Water-Works. E. Kuichling. A discussion of the administrative policy. 7000 w. Pro Am Soc of Civ Eng—April, 1897. No. 12516. $1.00.

GREATER NEW YORK.

The New Charter and the Water Supply. An abstract of the provisions relating to this subject. 800 w. Fire & Water—April 24, 1897. Serial. 1st part. No. 12361. 15 cts.

HIGH Buildings.

New System of Water Supply for High Buildings. W. S. Huyette. Illustrated description of the pressure system as installed in the Union Trust Building, Detroit, Mich. 800 w. Heat & Ven—April 15, 1897. No. 12243. 15 cts.

NEW BEDFORD.

The Further Water Supply of the City of New Bedford, Now Being Constructed. Edmund Wood. A rapid review of the work dwelling only on those things which may be of more especial interest. Also discussion. 7800 w. Jour N E Water Assn—March, 1897. No. 12124. 75 cts.

POLLUTION.

The Protection of Surface Waters from Pollution. W. T. Sedgwick. A review of the various sources from which the water supply may receive pollution, with discussion. 8500 w. Jour N E Water Wks Assn—March, 1897. No. 12126. 75 cts.

PUMPING.

Deep Well Pumping. E. E. Johnson. Discusses from an engineering and practical standpoint, the various types and kinds of pumping machinery applied to this service. Illustrations and discussions. 18800 w. Jour of W Soc of Engs—April, 1897. No. 12399. 45 cts.

Pumping Engines. Arthur J. L. Loretz. A survey of the subject with the conclusion that the lifting process is far preferable to forcing. Discussion. 7500 w. Jour N E Water Wks Assn—March, 1897. No. 12125. 75 cts.

RESERVOIR.

The Trenton Reservoir. Illustrated description of a large storage reservoir now in process of construction, which will have a capacity of 104,000,000 gallons, and cost nearly $350,000. 1200 w. Eng Rec—April 3, 1897. No. 12086. 15 cts.

SOUTH Australia.

Water Supply in South Australia. A brief account of the schemes for the supply of towns, and references to irrigation schemes proposed. 1200 w. Engng—April 23, 1897. No. 12562. 30 cts.

WATER Tower.

The Waterworks of Calbe. (Das Wasserwerk der Stadt Calbe.) A description of the water works of a small town in Germany, of interest because of the Béton tank in the water tower, constructed on the Monier System. 3500 w. Zeitschr d. Vereines Deutscher Ingenieure—March 13, 1897. No. 12404. 30 cts.

WATER-WORKS.

Khandwa Water-Works. L. M. St. Clair. History of the present town supply, quantity of water available, and schemes proposed for its improvement, with description of new works to be opened. Map. 4200 w. Ind Engng—March 27, 1897. Serial. 1st part. No. 12542. 45 cts.

Number and Ownership of Water-Works in the United States and Canada. Tabulated statements giving number and ownership and number of towns supplied, with other information; and remarks on the improvement in the standard of living, &c., by the introduction of a public water supply. 2800 w. Eng News—April 29, 1897. No. 12528. 15 cts.

Present Tendencies in Water-Works Practice. Editorial based upon information contained in the 1897 "Manual of American Water-Works." Calls attention to the new things since the publication of the last "Manual," discusses waters, pipes, and gives general review of notable tendencies. 2200 w. Eng News—April 15, 1897. No. 12206. 15 cts.

WELLS.

Driven Wells at Brookline, Mass. F. F. Forbes. Describes the principal details of construction of work done under the writer's direction, to increase the water supply of the town. Discussion. 2300 w. Jour of the N E Water Wks Assn—March, 1897. No. 12123. 75 cts.

COAL PRODUCTION.

The Production of Coal: Its Consumption and Cost. Presents the objections to the estimate of the consumption of coal per capita, and discusses the production of the different countries, and the cost of producing. 2000 w. Engng—March 26, 1897. No. 12070. 30 cts.

MISCELLANY.

DISINFECTION.

The Disinfecting Oven of Vaillard & Besson. (Der Disinfektions ofen von Vaillard & Besson.) A convenient portable steam apparatus for disinfecting clothing and bedding, especially adapted for military use. 1500 w. Gesundheits Ingenieur—Feb. 15, 1897. No. 12442. 30 cts.

The Epidemic Hospital at Brünn. (Die Epidemie-Spital in Brünn.) An account of the disinfecting apparatus, used in connection with the heating and drying plant, whereby a considerable economy is effected, and thorough sterilization insured. 2500 w. 1 plate. Gesundheits-Ingenieur—Feb. 28, 1897. No. 12444. 30 cts.

GLASGOW.

The Story of Municipal Glasgow. Review of a recent volume by Sir James Bell, very complimentary to the author. 2800 w. Jour Gas Lgt—March 30, 1897. No. 12147. 30 cts.

NEW YORK.

The Greater New York. Franklin Matthews. Justification of the project, with statistics, improvements under way, government and general discussion. Ill. 3000 w. Harper's Wk—April 17, 1897. No. 12193. 15 cts.

SANITATION.

Hygienic Demands for School Buildings. A. M. Sloan. Read at meeting of the State Health Authorities at Harrisburg. Discusses the need of intelligent consideration of the conditions, gives general rules, and requirements in the ventilation and heating. 4000 w. San—April, 1897. No. 12055. 45 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

COLUMBUS, O.

New Union Station at Columbus, O. Floor plans of building now in process of erection, with description. 1100 w. R R Gaz—April 30, 1897. No. 12536. 15 cts.

EXTENSION.

The National Docks & New Jersey Junction Connecting Railway. Map showing route and connections of an extension which, it is expected, will have the effect of considerably increasing the business and make possible a reduction in time and expense. 900 w. R R Gaz—April 9, 1897. No. 12138. 15 cts.

MANCHURIA.

The Projected Railway through Manchuria. (Die projectirte Eisenbahn durch die Mandschurei.) An account of the proposed diversion of the eastern section of the Trans-Siberian Railway through Chinese territory, with map. 1500 w. Zeitschd d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12415. 30 cts.

NEW ZEALAND.

Railway Construction in New Zealand. The standard specification used for co-operative contracts in government railways. 2000 w. Arch Lond—April 16, 1897. No. 12356. 30 cts.

RACK RAILWAY.

The Combined Adhesion and Rack Railway between Beirut and Damascus. (Combinirte Adhäsions und Zahnradbahn, Beirut-Damaskus.) A very complete account of this interesting road, with topographical map, illustrations of construction, locomotives, &c. The Abt system is used for the steep grades. 10000 w. Mitt d. ver f. d. Forderung d. Lokal & Strassenbahnwesers—Jan., 1897. No. 12448. 45 cts.

MAINTENANCE OF EQUIPMENT.

AIR GAGE.

Best Location for the Air Gage Where it Can be Seen by Night and Day. Extracts from a report of a committee of the Air-Brake-Men's Assn., critcizing and suggesting in regard to the importance in location of air gage. 2000 w. RR Gaz—April 30, 1897. No. 12537. 15 cts.

AUSTRIA.

Notes on the Austrian Railroads. John R. Slack. About half the roads are owned by the state and the tendency is toward the acquisition of the remaining roads. Illustrated description of standard type of locomotive. 1000 w. RR Gaz—April 9, 1897. No. 12141. 15 cts.

AXLES.

Tests of a Wrought-Iron Car Axle. W. F. M. Goss. Describes and illustrates recent test of a 60,000-pound axle made in the Engineering Laboratory of Purdue University. 1100 w. Pamphlet. No. 12588. 45 cts.

BRAKE GEAR.

Foundation Brake Gear for Locomotive Tenders. Extracts from report of committee of the Air-Brake Men's Assn. Considers brake power, piston travel, brakebeams, &c. 2200 w. RR Gaz—April 30, 1897. No. 12540. 15 cts.

CAR LIGHTING.

The Lighting of Railway Cars. (Eisenbahn-Waggon-Beleuchtung.) A paper by H. Gerdes, the chief engineer of the Pintsch establishment, making comparisons between oil, gas, electricity, and acetylene for car lighting. 5000 w. Glaser's Annalen—April 1, 1897. No. 12435. 45 cts.

CAR WHEELS.

Transverse Strength of Chilled Car Wheel Metal as Affected by the Relative Directions of Stress and Chill, with Some Notes on the Chemistry of Cast Iron. Asa W. Whitney. A study of the peculiarities of cast iron, and the phenomena due to the relations of stress and chill, Ill. 4000 w. Jour Fr Inst—April, 1897. No. 12112. 45 cts.

COUPLER.

A Car Coupler Decision. The decision rendered by Judge Taft in the case of the St. Louis

Car Coupler Co. against the National Malleable Castings Co. in favor of the latter. 1500 w. RR Gaz—April 9, 1897. No. 12140. 15 cts.

COUPLER.

An important Coupler Patent Decision. Decision of Judge Taft, with illustrations of various patents. 3400 w. Ry Rev—April 10, 1897. No. 12177. 15 cts.

JUNGFRAU.

The Track Construction of the Jungfrau Rack Railway. (Der Oberban der Jungfraubahn.) With especial details of the Strub system of rack construction especially designed for this Alpine road. 3000 w. Schweizerische Bauzeitung—April 3, 1897. No. 12411. 30 cts.

LOCOMOTIVE.

Locomotive for Japan Railway Company. General description with illustration. 700 w. Loc Eng—April, 1897. No. 12084. 30 cts.

Japanese Locomotives. A supplement sheet containing the illustrations of all the locomotives used on the Japanese railways under the superintendence of Mr. Trevithick, with tabular statement of dimensions. 3200 w. Eng, Lond—March 26, 1897. No. 12100. 30 cts.

Mogul Locomotive for the Imperial Railways of Japan—Rogers Locomotive Company. Engravings showing one of 18 locomotives recently built for this road. The principal dimensions are given. 700 w. RR Gaz—April 9, 1897. No. 12139. 15 cts.

The New Heilmann Electric Locomotive. Description with illustration. 1100 w. Elec Rev—April 21, 1897. No. 12284. 15 cts.

The Evolution of the American Locomotive. Herbert T. Walker. An attempt to trace the progress from the machine of ninety years ago to the engine of modern times. Ill. 2800 w. Sci Am Sup—April 24, 1897. Serial. 1st part. No. 12290. 15 cts.

MAIN-ROD Stresses.

A Method of Calculating the Greatest Stresses in Certain Main Rods When Used on Locomotives. George H. Goodell. Mathematical discussion. 1500 w. RR Gaz—April 16, 1897. No. 12209. 15 cts.

METAL TRUCK.

The Kindl Metal Truck for 100000 Pounds Capacity Cars. Truck designed by F. H. Kindl. Illustrated description of the interesting features. 500 w. RR Gaz—April 23, 1897. No. 12304. 15 cts.

PRIVATE CAR.

Lincoln's Private Car. Illustrated description. 1200 w. RR Car Jour—April, 1897. No. 12186. 15 cts.

Modern Private Cars. Duane Doty. General remarks on progress, with illustrated description of the private car "Alexander." 2000 w. RR Car Jour—April, 1897. No. 12185. 15 cts.

Proposed Design for the Presidential Car. Archer Richards. Illustrated description. 700 w. RR Car Jour—April, 1897. No. 12187. 15 cts.

SHOPS.

The Michigan Central Shops at Jackson. A brief description of the plant, with drawings of a number of special tools. 2000 w. RR Gaz—April 23, 1897. No. 12307. 15 cts.

STAYBOLTS.

Notes on the Breaking of Staybolts. (Bemerkungen über Stehbolzenbruche.) An examination of the probable cause of the frequent breakage of staybolts in particular locations in locomotive fire boxes. 1500 w. Zeitschr d. Oesterr Ing u. Arch Vereines—March 19, 1897. No. 12414. 30 cts.

TIRES.

Devices in Use for Heating Tires in Shrinking On and Removal. Illustrates and describes a convenient arrangement for the use of gasoline for tire-heating purposes, in use at the Missouri Pacific shops at St. Louis. 450 w. Ry Age—April 30, 1897. No. 12553. 15 cts.

VALVES.

The Pressure-Retaining Valve and its Use. Extracts from report of a committee of the Air-Brakemen's Assn. The history of the introduction of the retaining-valve in the air-brake service, with recommendations. 2200 w. RR Gaz—April 30, 1897. No. 12539. 15 cts.

VENTILATION.

Car Ventilation. Investigation of the subject, as reported in the latest annual report of the Massachusetts Board of Railroad Commissioners. 3000 w. Ry Rev—April 10, 1897. No. 12175. 15 cts.

The Ventilation of Cars with Filtered Air. (Lüftungseinrichtung für Eisenbalmwagen mittelst filtrirter Luft.) Describes a simple air filter which has given good results on the Hannover State Railway. 4000 w. Glaser's Annalen—March 15, 1897. No. 12432. 45 cts.

MAINTENANCE OF WAY.

BRIDGES.

Railroad Bridges and Buildings. Walter G. Berg. General remarks with a brief survey of the leading characteristics of the various structures and classes of work. 2500 w. Railway Mag—March, 1897. No. 12116. 30 cts.

BUILDINGS.

Assam-Bengal Railway Head Office Buildings, Chittagong. Illustrated description. 800 w. Ind Engng—March 6, 1897. Serial. 1st part. No. 12183. 45 cts.

CURVES.

The Union of Parallel Tracks into a Single Given Curve. (Einführung von Parallelgeleisen in eine bestehende Kurve.) A graphical solution of a special problem in railroad curves. 1000 w. Schweizerische Bauzeitung—March 27, 1897. No. 12410. 30 cts.

TRACKS.

Railroad Track Experiments. From the report of the Tests of Metals and Other Materials at the United States Testing Plant at Watertown, Mass., for the year 1895. Experiments and results, with editorial. Ill. 2900 w. Ry Rev—May 1, 1897. No. 12557. 15 cts.

TREE CULTURE.

Tree Culture by Railways. D. C. Burson. Comments on the prospect of a fuel and lumber famine, and calls attention to what could be accomplished by growing timber on vacant, unimproved right of way lands, and recommends the planting of the catalpa speciosa. 1800 w. Ry Age—April 2, 1897. No. 12063. 15 cts.

WASHOUT.

A Remarkable and Costly Washout. Brief account of the accident on the Evansville and Terre Haute railroad, near Hazleton, Ind. Diagram. 500 w. Ry Age—April 2, 1897. No. 12062. 15 cts.

SIGNALING.

INTERLOCKING.

Indiana State Law Regulating the Interlocking of Railway Grade Crossings. Abstract of the main provisions of a law just passed. 1000 w. Eng News—April 29, 1897. No. 12529. 15 cts.

Interlocking Plant, Dolton, Ill. Illustrated description of the largest interlocking plant in the United States. 900 w. Ry Rev—April 17, 1897. No. 12285. 15 cts.

TRANSPORTATION.

BRITISH RAILWAYS.

The Recent Prosperity of British Railways. William J. Stevens. Showing the extent and causes of the greater returns from British railway investments since June 1, 1895. 4400 w. Eng Mag—May, 1897. No. 12584. 30 cts.

EARNINGS.

Railway Earnings Still Improving. Tables of gross earnings for March, and of gross earnings and mileage for two years, with comments. 2500 w. Bradstreet's—April 10, 1897. No. 12143. 15 cts.

ELECTRICAL Haulage.

The Electrical Haulage System of the New Orleans & Western Railroad Company at Port Chalmette, New Orleans, La. W. Nelson Smith. Interesting installation, recently completed, showing the adaptability of electricity to the conditions of a railroad yard. Ill. 2500 w. Elec Wld—April 3, 1897. No. 12090. 15 cts.

GRAIN Transportation.

Russian Grain Transportation. Editorial comment on lately published statistics of the production and movement of grain. 1500 w. RR Gaz—April 23, 1897. No. 12308. 15 cts.

M. C. B. RULES.

M. C. B. Rules. The revision of the Master Car Builders' rules of interchange as recommended by the Southern & Southwestern Ry Club. 1100 w. RR Gaz—April 23, 1897. No. 12306. 15 cts.

PASSENGER Rates.

On Two Cents Per Mile Passenger Rates. Extracts from address of James Charlton before the Senate Committee and House Committee on Railroads, Illinois legislature, opposing the proposed reduced rates. 2700 w. RR Gaz—April 30, 1897. No. 12541. 15 cts.

POOLING.

The Foraker Bill. Full text of the new senate bill for the legalization of railway pooling, with editorial. 2800 w. Ry Age—April 9, 1897. No. 12152. 15 cts.

TRANS-MISSOURI Decision.

See same title under Economics and Industry. Governmental Control.

RAILROAD Law.

South Dakota Railroad Law. Summary of the provisions of the act passed by the last legislature, to regulate common carriers, etc. 1800 w. RR Gaz—April 30, 1897. No. 12535. 15 cts.

TRANSPORTATION.

Cheap Transportation in the United States. J. A. Latcha. Favoring transportation by railroad, and considering briefly canal transportation, which the writer thinks has in general passed the era of its usefulness. The requisites for improvement are discussed. 6000 w. N Am Rev—May, 1897. No. 12510. 45 cts.

The Relation of Railroads and Localities. A. J. Vanlandingham. From an address before the Commercial Club of Kansas City. A discussion of rates and related questions. 1200 w. Ry Rev—April 10, 1897. No. 12176. 15 cts.

MISCELLANY.

ACCIDENTS.

Train Accidents in the United States in March. Classified statement of accidents of the month with summary. 2500 w. RR Gaz—April 23, 1897. No. 12305. 15 cts.

ACCOUNTING.

Motive Power Accounting. W. G. Taylor. Reviews the most important features, and the importance of accuracy in details, &c. 3000 w. Railway Mag—March, 1897. No. 12115. 30 cts.

ASIA.

A Visit to Russian Central Asia. Michael Francis O'Dwyer. An interesting, descriptive paper, containing information concerning the Transcaspian railway. Also discussion. Ill. 25000 w. Jour Soc of Arts—April 16, 1897. No. 12235. 30 cts.

CHINA.

Opportunities for American Engineers and Railway Builders in China. R. Van Bergen. Showing that the conditions are favorable for business in this field. 800 w. Eng News—April 29, 1897. No. 12527. 15 cts.

Railway Development in the Celestial Empire. Information of proposed undertakings, their routes, and the effect looked for on the country. 2000 w. Trans—April 16, 1897. No. 12372. 30 cts.

Railway Prospects in China. Considers the interests and influence of Russia in this field, also the other forces at work. 2200 w. Engng—March 26, 1897. No. 12069. 30 cts.

COMPRESSED AIR.

The Uses of Compressed Air on Railways. J. H. McConnell. Calls attention to the many uses in train service and shop, and the large extent to which it has replaced hand labor and steam. 1400 w. Railway Mag—March, 1897. No. 12114. 30 cts.

CURVES.

Transition Curves. Letters from various correspondence bearing on this subject. 2500 w. Eng News—April 15, 1897. No. 12207. 15 cts.

ELECTRIC Traction.

See same title under Street and Electric Railways.

ELECTRICITY.

The Application of Electricity to Railway Working. Review of a book by W. E. Langdon, superintendent and engineer of the electrical department of the Midland Railway. 2000 w. Trans—March 26, 1897. No. 12093. 30 cts.

MEXICO.
See same title under Economics and Industry. Miscellany.

PRUSSIA.
The Prussian State Railroads. Editorial on report recently issued recording the results from the new organization in force since April 1, 1895. 1350 w. RR Gaz—April 9, 1897. No. 12142. 15 cts.

RAILROAD Securities.
The Increased Confidence in American Railroad Securities. Thomas F. Woodlock. Showing that railroads should not, by the issue of long-term bonds, sacrifice advantages arising from future improvement in credit. 3200 w. Eng. Mag—May, 1897. No. 12578. 30 cts.

REFUNDING.
New York Central Refunding. A statement of the plan in brief. 500 w. Bradstreet's—April 17, 1897. No. 12217. 15 cts.

VENEZUELA.
Venezuela Railroad Development. Report of the Puerto Gabello & Valencia Railway, and the Great Venezuela Railway. A descriptive and historical sketch. 5500 w. Cons Reports—April, 1897. No. 12395. 45 cts.

STREET AND ELECTRIC RAILWAYS.

ACCOUNTANTS.
Papers Read at the Convention of Street Railway Accountants at Cleveland, March 23-24. Papers by H. L. Wilson, P. V. Burington, J. P. E. Clark, W. B. Brockway, Frank R. Greene, Dana Stevens, and C. N. Duffy on subjects of interest to accountants. 11500 w. St Ry Jour—April, 1897. No. 12075. 45 cts.

ACCUMULATORS.
Accumulator Tramways. (Ueber Akkumulatorenbahnen.) A paper before the Electrotechnical Society of Cologne, dealing mainly with the commercial results of the use of storage batteries on various German tramways. 5000 w. Elektrotechnische Zeitschr—April 1, 1897. No. 12470. 30 cts.

BUDAPEST.
The Budapest Underground Electric Railway. Illustrated description of this subway which has been working some months with success. 2500 w. Ry Wld—April, 1897. No. 12265. 30 cts.

CAR MOTORS.
Controlling the Speed of Car Motors. William Baxter, Jr. An explanation of the methods used. 1800 w. Elec Wld—April 10, 1897. Serial. 1st part. No. 12172. 15 cts.

CHICAGO.
The Suburban Railroad Company, Chicago. Illustrated description of construction with other information. 1800 w. St Ry Rev—April 15, 1897. No. 12258. 30 cts.

COMPRESSED AIR.
Compressed Air for Street Railway Service. Experience. A criticism of General Haupt's assertions as published in the N. Y. Sun. 1200 w. Elec Rev, Lond—April 7, 1897. No. 12106. 15 cts.
See also title "Compressed Air" under Railroad affairs. Miscellany.

CONDUITS.
Feeder-Conduit Construction. N. S. Hill, Jr. Extract from report made by the Electrical Commission of the city of Baltimore. The different styles of conduits and methods of ventilating them. 1600. St Ry Jour—May, 1897. No. 12550. 45 cts.
The "Simplex" Conduit Electric Tramway. Illustrated description of this inverted trolley system. 3000 w. Ry Wld—April, 1897. No. 12267. 30 cts.

CONSTRUCTION.
The System of the Canal & Claiborne Railroad Company. Illustrated detailed description. 10000 w. St Ry Jour—May, 1897. No. 12547. 45 cts.

ELECTRIC Railway.
Electric Railway Engineering. Alex. McCallum. The modifications required for British conditions. It is thought that the Board of Trade regulations will increase the initial cost by from 30 to 40 per cent. on long lines. 1600 w. St Ry Jour—April, 1897. No. 12077. 45 cts.
The Lorain and Cleveland Electric Railway. Illustrated detailed description of an inter-urban road recently constructed. 2000 w. St Ry Jour—April, 1897. No. 12076. 45 cts.

ELECTRIC Traction.
Electric Traction under Steam-Railway Conditions. Charles Henry Davis. Showing under what circumstances electric traction may be profitably substituted for steam locomotion. 4400 w. Eng Mag—May, 1897. No. 12579. 30 cts.
Direct-Coupled versus Belt-Driven Units for Electric Traction. Alfred H. Gibbings. Considers briefly the advantages of direct-coupled engines and dynamos as compared with those which are coupled by rope or belt gearing. 1500 w Ry Wld—April, 1897. Serial. 1st part. No. 12266. 30 cts.
Some Recent Developments in Electric-Traction Appliances. A. K. Baylor. Part first is a comparison of a modern traction generating plant with one of seven or eight years ago. Ill. 1300 w. Elec Eng, Lond—April 9, 1897. Serial. 1st part. No. 12251. 30 cts.

EUROPEAN Electric Roads.
Electric Railway Practice in Europe. The principal street railway systems of several European cities are described with special reference to the engineering methods adopted in the construction of their road bed, their overhead construction, their power stations and their rolling stock, and to the financial results which have so far come from the introduction of electricity. Also editorial. Ill. 12500 w. St Ry Jour—April, 1897. No. 12072. 45 cts.
Comparison of Street Railway Conditions and Methods in Europe and in the United States. P. F. Sullivan. Glasgow and Berlin are selected as typical cities, and comparison

made, showing fares to be actually higher, distance rates not advisable, and street railway investments more desirable. 9500 w. St Ry Rev—April 15, 1897. No. 12259. 30 cts.

GENERATORS.

Connections of Railway Generators. J. E. Woodbridge. Describes the plan of a proposed system, stating its advantages. 700 w. Elec Wld—April 17, 1897. No. 12279. 15 cts.

GREECE.

Street and Other Railways in Greece. Nicholas D. Sourmely. Thinks it a good field for American contractors, locomotive, and rolling-stock builders to transact business. 1200 w. St Ry Jour—April, 1897. No. 12078. 45 cts.

HAMBURG.

The Introduction of Electric Power on the Hamburg-Altona Central Tramway. (Die Einführung des Elektrischen Betriebes bei der Hamburg-Altonaer Zentralbahn.) Illustrated description of an important overhead trolley line, with details of motors, switchboard, &c. 3500 w. Zeitschr d. Vereines Deutscher Ingenieure—March 6, 1897. No. 12402. 30 cts.

HANNOVER.

The Hannover Electric Tramway. (Die Elektrische Strassenbahn in Hannover.) A description of the tests and performance of a combined overhead trolley and accumulator system. The accumulators serve not only to propel the cars through the central portion of the city, but also act to equalize the demands upon the generators. A valuable paper. 7500 w. Elektrotechnische Zeitschr—April 1, 1897. No. 12467. 30 cts.

HUMPHREY Bill.

The Real Question in the Humphrey Bill. A bill for the protection of street-railway companies, which recently passed the Illinois senate is explained. 1000 w. Ry Age—April 23, 1897. No. 12343. 15 cts.

ILLINOIS.

Street Railways of Illinois and Their Franchise Conditions. Abstract of statement made by the presidents of several of the principal Chicago street railway lines, in reference to the growth of the street railways in this country, their relation to the growth of cities, and on the demand for lower fares. 6000 w. St Ry Jour—May, 1897. No. 12552. 45 cts.

ITALY.

Street and Steam Railways in Italy. F. Benedetti. Considers mainly the lines propelled by steam, and discusses their relation to modern life as shown in Italy. 2000 w. Chau—May, 1897. No. 12358. 30 cts.

OPERATION.

Stopping Another Leak in Electric Railway Operation. J. R. Cravath. Illustrated description of recorder, with tests, and the benefits from its use. 3000 w. St Ry Rev—April 15, 1897. No. 12260. 30 cts.

POWER Station.

Power Station Controversy in Chicago. An abstract of the reports of Messrs. Peirce, Richardson & Foster, and R. J. Hill on the Chicago city plants, after critical examination. 6000 w. St Ry Jour—May, 1897. No. 12548. 45 cts.

RAIL JOINTS.

The Construction of Rail Joints. Alfred Birk. Extract from an article published in the Bulletin of the International Railway Congress. Illustrates and discusses the various kinds of joints, and draws conclusions from the investigations. 3500 w. St Ry Jour—May, 1897. No. 12551. 45 cts.

RAPID Transit.

Notes on Rapid Transit. W. L. Derr. Full paper with appendix and discussion. Ill. 31000 w. N Y R R Club—March 18, 1897. No. 12222. 45 cts.

Requirements of High Speed and Heavy Electric Traction. Hayward Cochrane and E. J. Swartout. The paper aims to present the practical conclusions of the best authorities and to suggest outlines of what the writers consider to be the best results obtainable from the use of electrical machinery as now manufactured. Read before the Chicago Elec. Assn. Ill. 3500 w. W Elect'n—May 1, 1897. No. 12522. 15 cts.

The Reno Rapid-Transit Plan for Broadway, New York. J. W. Reno. An article aiming to show that an economical rapid transit system may be constructed at a cost of construction not above $35,000,000. Ill. 1300 w. Sci Am Sup—April 24, 1897. No. 12291. 15 cts.

STREET Railways.

An Informal Talk on Financial Practice and Engineering Methods of American Street Railways. E. E. Higgins. Delivered before the New York Electrical Soc. at Columbia College. Part first explains why the street railway section of the country is necessarily in the east, gives a brief historical review, and discusses franchises and burdens. 2300 w. Elec—April 14, 1897. Serial. 1st part. No. 12195. 15 cts.

TESTS.

Important Electric Railroad Tests. Brief illustrated account of tests made by the General Electric Co. on its own special line of track at Schenectady, N. Y. 1000 w. Ir Trd Rev—April 8, 1897. No. 12133. 15 cts.

TRACKS.

New Track Construction in Pittsburg. Description with extracts from specifications. 1300 w. St Ry Jour—May, 1897. No. 12549. 45 cts.

TRAMWAYS.

Modern Electric Tramway Systems. (Neuere Systeme Elektrischer Bahnen.) A paper before the electrotechnical society of Cologne, discussing overhead and underground trolley systems, as well as the combination of overhead wire and accumulators. 3500 w. Elektrotechnische Zeitschr—March 25, 1897. No. 12466. 30 cts.

TROLLEY.

Sliding vs. Rolling Contact for Electric Tramways. (Ueber Bügel-und Rollen-Kontakt be Elektrischen Strassenbahnen.) Showing that with a properly constructed sliding contact there is less wear on the conducting wire than with the roller, owing to the action of the sides of the grooves in the trolley roller. 2000 w. Deutsche Zestschr für Elektrotecknik—March, 1897. No. 12457. 30 cts.

TROLLEY Servitudes.

The Connecticut Decision on Trolley Servitudes. Editorial on the decision of the Connecticut Supreme Court that an electric railroad in a street is not necessarily an additional servitude, entitling the adjacent land owner to damages. 1300 w. RR Gaz—April 16, 1897 No. 12211. 15 cts.

BOOKS OF THE MONTH

Adams Patent Sewage Lift Co., London, Eng. Sewer-Flushing Diagrams for Engineers, Surveyors, etc. Spon & Chamberlain, New York; E. and F. N. Spon, London. Printed on stiff boards, without cover. Price, $5.

These diagrams are intended for, and will be effective in, saving labor in calculating the value of any given flush upon a sewer. The diagrams are made from actual readings—surface velocities—taken as from manhole to manhole, but averaged in cases of extreme irregularity, as through blockage or unusually faulty construction. Full explanations of the use of the diagrams are given, and from them can be seen how far the discharge from a flush-tank will give a self-cleansing velocity.

Spalding, Frederick P., assistant professor of engineering at Cornell University. Hydraulic Cement; Its Properties, Testing, and Use. John Wiley & Sons, New York. 1897. Cloth. Price, $2.

The results of careful study are embodied in this book, and the various tests for cements are discussed. Prof. Spalding gives free expression to his own opinions. The results of investigations carried out in Europe, and the recommendations of commissions appointed in Europe, form an important part of the treatise. Sample specifications are appended to the final chapter, which treats of cement, mortar, and concrete. In the present confused condition of opinion regarding the testing of cement, this work will be a guide to the best current practice.

Suplee, Henry Harrison, B. Sc., member of American Society of Mechanical Engineers, and of the Franklin Institute. Mathematics Self-Taught: The Lübsen Method for Self-Instruction and Use in the Practical Problems of Life. I. Arithmetic and Algebra. Adapted from the German of H. B. Lübsen. Published by the author, West Chelten Avenue, Philadelphia, Pa.

Mr. Suplee states in his preface that this is an effort to place before English-speaking students a treatise on arithmetic and algebra, freed from technicalities and expressed in simple language, which "will assist many who are compelled to study alone." He also thinks "it may not be unwelcome to some who wish to 'brush up' their rusty mathematical information, acquired long years ago under scholastic methods and not improved by years of disuse." A very cursory examination of the pages of the volume will convince mathematicians that the effort to do this has succeeded. The volume translated by Mr. Suplee has passed through twenty-seven editions in German, which sufficiently indicates its repute in German-speaking countries. But Mr. Suplee has done more than translate; he has added, edited, and adapted, to meet the wants of English-speaking students. The additions consist chiefly of Prof. Robinson's method of approximating roots, examples for practice, and Walenn's method of verifying the accuracy of products by "imitation." We heartily commend this book to all who seek the aid it is intended to supply.

Johnson, Prof. J. B., C. E. The Materials of Construction. A Treatise for Engineers on the Strength of Engineering Materials. First Edition. John Wiley & Sons, New York. 1897. Cloth, $6.

The author is professor of civil engineering in Washington University, St. Louis, Mo., and ranks high, both as practical engineer and instructor. He is a member of many of the most prominent engineering societies, among which is the International Association for the Standardizing of Methods of Testing Materials. The fact of this latter membership is alone a sufficient warrant of his eminent fitness to prepare the treatise, the name of the publishing firm being also a warrant of excellence in printing and illustration. As chairman of the board of managers of the Association of Engineering Societies, Professor Johnson was editor of the index of engineering literature which appeared for some four years in the *Journal* of the Association of Engineering Societies, and which is now merged in the "Engineering Index," regularly published by THE ENGINEERING MAGAZINE. The book now under discussion is, in our opinion, destined to become at once a standard authority among engineers and architects. Prof. Johnson has given to the engineering profession a book which will long rank as a leading authority. The work is divided into four parts:

I. Synopsis of the Principles of Mechanics underlying the Laws of the Strength of Materials. II. Manufacture and General Properties of the Materials of Construction. III. The Methods of Testing the Strength of Materials. IV. The Mechanical Properties of Materials of Construction as Determined by Actual Tests. It is a handsome octavo of 787 pages.

Allen, C. F., Associate Professor of Railroad Engineering, Massachusetts Institute of Technology. Tables for Earthwork Computation. Published by the Author. Boston, Mass. 1893. Cloth, $1.50.

By the aid of these tables the labor of earthwork computation may be very much simplified and lessened. Table I is for sections of any base or slope, irregular as well as regular. Table II gives readily results correct by the prismoidal formula. Provision is made in Table III for very rapidly taking out quantities for level sections, when the center heights alone are given; a limited number of the most common bases and slopes are also provided for. Great accuracy is claimed. The author will be thankful to be informed of any error that may be discovered.

Edward B. Smith & Co., New York. The Application of Paints, Varnishes, and Enamels for the Protection of Iron and Steel Structures and Hydraulic Work. Third Edition, enlarged.

This may be fairly described as an invaluable text-book upon the subjects indicated. It consists in the main of papers read by Mr. A. H. Sabin before the American Society of Civil Engineers, and other technical organizations of high standing, and, though it is issued free of charge, it contains but one page of advertising, and it should find a place in every engineer's library.

BOOKS ANNOUNCED.

Ebert, H. Magnetic Fields of Force. An Exposition of the Phenomena of Magnetism, Electro-Magnetism, and Induction Based on the Conception of Lines of Force. Translated by C. V. Burton. Part 1. Longmans, Green & Co. New York, 1897. Cloth, $3.50.

Van Ornum, J. L. Topographical Surveys. Their Methods and Value. University of Wisconsin. Madison, Wis. 1897. Paper, 35 c.

Cottage Designs, with Constructive Details by various architects. A Practical Book for Builders and Those Intending to Build. D. Williams. 1897. Paper, $1.

Kellog, Day Otis, D. D. Editor. New American Supplement to the Latest Edition of The Encyclopedia Britannica. The Werner Company, New York and Chicago. 1897. Cloth (subs.), $3.

Butterfield, W. J. Atkinson. The Chemistry of Gas Manufacture. A Handbook on the Production, Purification, and Testing of Illuminating Gas, and Assay of By-Products of Gas Manufacture. Imported by J. B. Lippincott Co., Philadelphia. 1896. Cloth, $3.50.

Carter, E. Tremlett. Motive Power and Gearing for Electrical Machinery. A Treatise on the Theory and Practice of the Mechanical Equipment of Power Stations for Electrical Supply and for Electric Traction. D. Van Nostrand Company. 1897. Cloth, $5.

Dodsworth, Walter. The Commercial Year-Book. A Statistical Annual Relating to the Commerce, Industries, Agriculture, Banking, Currencies, Investments, Railroads, Shipping, Insurance, Population, etc., of the United States and Foreign Countries. The *Journal of Commerce* and Commercial Bulletin, 1897. Cloth, $1.50.

Donkin, Bryan, Jr. Gas, Oil, and Air Engines. Practical Text-Book on Internal Combustion. Motors without Boilers. Second edition, revised and enlarged. J. B. Lippincott Co., Philadelphia. 1897. Cloth, $7.50.

Levasseur, E. The Concentration of Industry and Machinery in the United States. American Academy of Political and Social Science, Philadelphia. 1897. Paper, 25 cts.

Rideal, S. Water and its Purification. A Hand-Book for the Use of Local Authorities, Sanitary Officers, and Others Interested in Water-Supply. Imported by J. B. Lippincott Co., Philadelphia. 1897. Cloth, $2.50.

Mackenzie, T. Practical Mechanics Applied to the Requirements of the Sailor. J. B. Lippincott Co. 1897. Cloth, $1.50.

Anderson, W. J. The Architecture of the Renaissance in Italy. A General View for the Use of Students and Others. Imported by C. Scribner's Sons. 1897. Cloth, $5.

O'Donahue, T. A. Colliery Surveying: A Primer Designed for The Use of Students and Colliery Manager Aspirants. The Macmillan Co., New York. 1897.

Phillips, Jos. Wood Carving, Being a Carefully Graduated Educational Course for Schools and Adult Classes. Imported by C. Scribner's Sons, New York. 1897. Cloth, $1.

Wilson, H. M. Manual of Irrigation Engineering. Second edition, revised and enlarged. J. Wiley & Sons, New York. 1897. Cloth, $4.

Woollcombe, W. Practical Work in Physics for Use in Schools and Colleges. Part 3.—Light and Sound. The Macmillan Co., New York. 1897. Cloth, 90c.

Ames, Jos. S. Theory of Physics. Harper, New York. 1897. Cloth, $1.60.

Anthony, W. A., and Brackett, Cyrus F. Elementary Text-Book of Physics. New edition revised by W. F. Magie. J. Wiley & Sons, New York. 1897.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Montgomery & Co., New York.=(a) An important and voluminous tool catalogue for 1897. Royal octavo of 710 pages, bound in stiff buckram covers. An illustrated price-list of supplies, tools, and machinery for all mechanical trades. (b) Discount sheet to accompany this catalogue. The lines listed are very extensive and comprehensive.

The Ingersoll-Sergeant Drill Co., New York. =Pamphlet entitled "Water Pumped by Compressed Air," illustrating and describing the Pohle air-lift pump system, explaining the principles upon which it does its work, setting forth the conditions for obtaining highest efficiency, and showing the superior advantages and economy of this system for pumping water in many situations and under various conditions. It also describes and illustrates air compressors found best adapted to this kind of service and explains different methods of piping artesian wells, and a method of regulating flow. In addition there is an enumeration of various places and water works where the system is used, and where it is giving great satisfaction, as indicated by numerous testimonials.

The J. M. Carpenter Tap and Die Co., Pawtucket, R. I., U. S. A.=Catalogue No. 11 B., illustrating and describing a list of goods manufactured for bicycle work.

Ramapo Iron Works, Hillburn, Rockland Co., N. Y., U. S. A.=Illustrated catalogue of switches and frogs for railways.

Link Belt Machinery Co., Chicago, U. S. A., New Orleans, La., U. S. A.=Illustrated and beautifully-printed pamphlet entitled "Modern Methods, as Applied to the Coaling of Locomotives, the Handling of Freight in Warehouses and Wharves, and the Storage of Coal." The modern methods here spoken of are those introduced by this company.

National Lead Co., New York.=Pamphlet, "Why and How to Use Red Lead," to secure simplicity, certainty, and permanence. A refutation of attacks upon the use of red lead, by parties interested in the manufacture of other paints.

Royal Electric Company, Peoria, Ill., U. S. A.=Pamphlet, "Facts Worth Considering and of Interest to You." A collection of letters from users of the "Royal" Alternator, testifying to its simplicity, efficiency, and durability.

The Q. & C. Company, Chicago, U. S. A.= (a) Illustrated and beautifully-printed pamphlet, describing the "McKee Brake Slack Adjuster." (b) Leaflet, illustrating and describing the "Williams" portable stay-bolt drilling machine.

Joseph Dixon Crucible Co., Jersey City, N. J., =Pamphlet describing a long line of Dixon's graphite productions manufactured only by this company.

Dietz, Schumacher & Boye, Cincinnati, Ohio. =Catalogue of the line of machine tools manufactured by this firm.

S. Morgan Smith Co., York, Pa., U. S. A.= Descriptive, illustrated catalogue of the McCormick Turbine, manufactured by this company, with appended tables of data.

Thomas Carlin's Sons, Allegheny, Pa., U. S. A. =Eighth Illustrated Catalogue of engines, boilers, brick plant and hoisting machinery, city and park sewer castings, etc.; 229 pages octavo, cloth binding.

Johnson & Phillips, Victoria Works, Old Charlton, Kent, and Union Court, Old Broad Street, London, E. C.=Sheet No. 3, containing eighteen engravings of cable-making and wire-covering machinery, with accompanying descriptions of each on separate sheets fastened together.

Lehigh Valley Railroad, Philadelphia, Pa.= First number of a new illustrated quarterly issued by this company under the name, "*Black Diamond Express*," and devoted to the business and business interests of the road. It is a handsomely-printed and an interesting publication.

Davis & Egan, Cincinnati, Ohio, U. S. A. New York. Chicago. St. Louis. Boston. Philadelphia.=Elegantly-printed and illustrated quarto catalogue of a long line of machine tools manufactured by this company, successors to the Lodge & Davis Tool Co.

Blackmer & Post Pipe Co., St. Louis, Mo., U. S. A.=Illustrated pamphlet entitled "Something about Culvert Pipe," which describes the vitrified pipes made by this company, beginning with the material and its preparation, and sets forth at length, for the information of railroad men and engineers in general, the uses of this pipe and the relation it bears to railroad construction, special mention being made of "Double Strength" pipe extensevely used by railway and construction companies.

Jeffrey Manufacturing Co., Columbus, Ohio, U. S. A. (Branches at New York and Denver).= Elegantly-printed and illustrated descriptive catalogue of chain belting, steel cable, elevating and conveying machinery, elevators, and conveyors, carriers, labor-saving appliances, power-transmission machinery, mill, factory and mine supplies, coal-washing and mining machinery.

The Electric Storage Battery Company, Philadelphia, Pa., U. S. A.=Catalogue A, 10th edition. Illustrates and describes a line of "chlorid" accumulators, and enumerates the various uses to which these accumulators can be economically and advantageously applied. Also includes a series of specifications of accumulators of different sizes, with prices.

American Impulse Wheel Company, of New York.=Illustrated pamphlet, (stiff covers) describing the "Perfect American Hurdy Gurdy," and considering its principles of construction and operation in the light of modern hydraulics.

The conditions of maximum efficiency are considered, and the symbols and equations for the computation of values in the estimation and survey of water power are presented both in the foot-pound system, and in the metric system, with an explanation of their use. A table of pressure-equivalents, horse-power, quantity of water, and number of revolutions under heads of from nine to two thousand feet, computed and arranged by F. M. F. Cazin, (inventor of the "Cazin Standard-Wheels" manufactured by this company), is embodied in the pamphlet, and a table of equivalents of units of energy and work is appended.

C. M. Giddings, M. E., Rockford, Ill., U. S. A.=(*a*) Circular illustrating and describing Giddings "Universal" valve-movement model (four models in one) to illustrate Corliss valve gear, single or double D-valves, siding cut-off valves, double-ported slide, and piston valves. (*b*) Circular (with blue-print samples) of sets of working drawings of steam engines supplied by Mr. Giddings, (ten different sizes). (*c*) Circular illustrating and describing the Giddings' "Commercial" automatic governor.

Cincinnati Screw and Tap Co., Cincinnati, Ohio, U. S. A.=(*a*) Leaflet,—description of Howe's special tool steel, and price-list of "Decimal" polished-steel drill-rods. (*b*) Leaflet,—price-list of taps, dies, screws, nuts, etc.

Buhl Stamping Co., Detroit, Mich., U. S. A. =(*a*) Pamphlet illustrating and describing a line of lanterns manufactured by this company. (*b*) Circular illustrating and describing cans for milk, etc., comprising description of the "Buhl Rustless" can, etc.

Globe Chuck Co., Washington, D. C., U. S. A =Illustrated catalogue and price-list of Globe Chucks.

James L. Robertson & Sons, successors to Hine & Robertson Co., New York=Illustrated pamphlet describing steam indicators, gage-testing apparatus, etc.

R. M. Clough, New Haven, Conn., U. S. A. =Catalogue and price-lists of gear and milling cutters and small tools.

Norton Emery Wheel Co., Worcester, Mass., U. S. A.=(a) Pamphlet illustrating and describing the Bath indicator for testing the truth and alignment of machine parts. (b) Illustrated catalogue of emery goods and grinding machinery.

American Steam Gage Co., Boston, New York, and Chicago=Illustrated descriptive catalogue of gages, etc.

Philadelphia Engineering Works, Limited, Philadelphia, Pa.=Illustrated pamphlet describing the Philadelphia water-tube safety boiler, with dimension tables and other data; and calling attention to condensers, air-pumps, feed-water heaters, steel-plate chimneys, and gas and air compressors manufactured by the same establishment.

Clayton & Lambert Mfg. Co., Ypsilanti, Mich., U. S. A.=Pamphlet entitled "Gasoline Fires and Hose Fittings." Illustrates and describes not only gasoline fires, but also a number of devices pertaining to the rubber-hose trade.

Taylor, Wilson & Co., Limited, Allegheny, Pa., U. S. A.="Hand Book of Gearing." Formulæ and tables relating to transmission of power by gearing and belting, accompanied by a catalogue of the manufactures of this company, inclusive of pipe-mill machinery, foundry equipment, water-works and gasoline connections, gas producers, etc., etc.

The Quaker City Electric Company, Philadelphia, Pa., U. S. A.=Descriptive and illustrated catalogue of dynamo-electric machinery for light and power.

Blackner & Post Pipe Co., St. Louis, Mo., U. S. A.=Pamphlet entitled "Vitrified Pipe vs. Brick Sewers." Illustrates and describes vitrified standard culvert and sewer pipe thirty inches in diameter, and sets forth its superiority to brick sewers.

The Pennock Electric Co., New York=Pamphlet treating of the inventions and improvement in the field of electricity attributed to Mr. Geo. B. Pennock, the president and general manager of the company.

Betts Machine Company, Wilmington, Delaware, U. S. A.=Pamphlet illustrating and describing extension boring and turning mills manufactured by this company.

Reynolds & Co., New Haven, Conn., U.S.A. =(*a*) Catalogue illustrating and describing molding machines for metal castings. (*b*) Price list of set, cap, and machine screws, machine bolts, and coach screws.

Hobson & Company, Tatany, Pa., U.S.A.= Illustrated catalogue of tip-carts, two-wheel timber trucks, express and contractor's wagons, etc.

Edwin Harrington, Son & Co., Philadelphia, New York.= (*a*) Pamphlet entitled "Pointer No. 2, 1896." Illustrates and describes a line of elevators and dumb waiters. (*b*) Pamphlet illustrating and describing hoists, tramways, and traveling cranes.

Nagle Engine & Boiler Works, Erie, Pa., U. S.A.=Catalogue of portable, stationary, agricultural, and vertical steam engines and boilers, gasoline engines and the "Ennes" tubular well machine.

Tower & Lyon, New York.=No. 10 illustrated catalogue of hardware specialties, fine tools, and police equipments: including also goods of the Union Hardware Co., such as skates, dog-collars, gun implements, wood goods, tackle blocks, etc.: Also goods of the International Glue Co.,—"Martin's" liquid fish glue, belting cement, "Mystic" glue, etc.

Milne Manufacturing Co., Monmouth, Illinois, U. S. A.=(*a*) Annual catalogue illustrating and describing "Hawkeye" grub and stump machine, the "Iron Giant" grub and stump machine and "I. X. L." grubber. Milne's patent wire-rope cutter, and Milne's rope hook. (*b*) Leaflet illustrating and describing the "Victoria" tilting clothes reel.

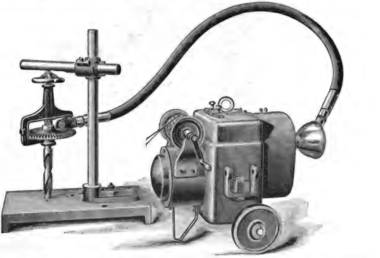
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "Stow" Flexible Shaft and "Iron Clad" Electric Motor.

THIS combination of the "Stow" flexible shaft with the new "Iron Clad" electric motor, designed and manufactured by the Stow Manufacturing Company, Binghamton, N. Y., as adapted to drilling, tapping, seaming, etc., is well illustrated in the accompanying engraving, which tells its own story so far as the application is concerned. The motor, however, requires more detailed mention. The combination of an electric motor with a flexible shaft for the performance of this class of work, has been in use for some years, and, in the main, has given good satisfaction. There yet remained, however, some improvements needed to bring this combination to practical perfection as voiced in the demand which has sprung up for a dust- and water-proof motor which this new "Iron clad" motor has been designed to meet. The frame of this motor is in the form of a hollow cube with inwardly-projecting poles. In each end of the frame is a circular aperture, over which is bolted the end plates supporting the bearings. One of these is extended into a short cylinder forming a case for the commutator and brush holder. The field coils are protected by metallic cases and can be easily removed. The motors below 2 H. P. are bipolar and those of 2 H. P. and over have four poles. The best of material is used in construction. Self-oiling bearings; mica insulation; rheostats protected by iron case; gears covered and, by simply changing the end plates, to bring the oil chambers below the bearings, this motor can be run in almost any position. Motors of this type can be furnished for direct connection when desired, also for electric street-railway track drilling. The portable motors, as shown, are fitted with truck wheels, leg, eye bolt, side brackets, reel, twenty yards of insulated wire, and one set of reduction gears. By use of speed regulator and gears, almost any practical speed can be obtained. Either the company or their European Agents, Messrs. Selig, Sonnenthal & Co., 85 Queen Victoria St., London, E. C., may be addressed for prices or for further information.



A New Pipe-Threading Machine.

THIS machine was designed to respond to frequent calls for a machine threading from ¼ to 2 inch pipe, and its designers, The Armstrong Manufacturing Company, 139 Center street, New York, claim to have turned out a superior tool for this purpose.

The machine uses the well-known regular Armstrong adjustable dies which are put in the machine and adjusted in the same manner as in the hand stock, and which can be opened for removing the pipe after cutting a thread and then locked back to the standard size without resetting. The dies, in this machine can be adjusted, however, to the variations of the fittings, the same as in the hand stock. All the gears and moving parts run in oil enclosed in a chamber covering and protecting them from chips and dust. The machine is thus self-oiling in all its parts, oil being put in through two holes provided with screw plugs.

It is impossible for the die-head to get loose, a common occurrence with some makes of pipe-threading machines. An inner journal increases the wearing surface of the bearings of the die-carrying head. A very powerful self-centering vise, exerting its power from the center of the jaws and not on the side, holds the pipe while being threaded.

The machine may be adjusted to a post on the side of a building, or on a bench, which is a new and special feature of this tool.

The machine has two speeds, a change from one to the other being effected by merely removing the crank from one spindle to the other. This enables the operator to cut from ⅛" to 1" pipe inclusive with great rapidity, and then by changing to the other speed, he can cut from 1¼" to 2" inclusive.

The machine can be furnished with dies for threading pipe from ⅛" to 2", either right or left, or with bolt dies for threading from ½" to 1½" rod, inclusive, also with dies for threading brass tubing.

NO. "0" ARMSTRONG PIPE-THREADING MACHINE.

This new pipe-threading machine attracted much attention at the Gas Exposition recently held in Madison Square Garden, N. Y. City. The Armstrong Manufacturing Company may also be addressed at its factory in Bridgeport, Conn.

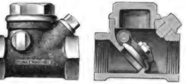
The Jeffrey Coal-Washer at Columbus, Ohio.

THE now completed Jeffrey coal-washer, at Columbus, Ohio, will be of much interest to all coal operators who are at all interested in the washing of their smaller coal with a view of not only getting rid of the impurities, but also of

putting it in a better marketable condition. The Robinson-Ramsay system under which the Jeffrey Company is working has been previously and fully described in our columns. The object of erecting the particular washer under present consideration was to wash such coal as may be sent to the company from time to time with a view of ascertaining the result. Up to the present time quite a number of coal operators have taken advantage of this, the only plant of its kind erected solely for testing purposes. The plant consists of a 200-ton washer and is such as would be supplied to any coal operator. If any coal operators are contemplating the use of such machinery they can arrange with the Jeffrey Company at Columbus to wash one or more carloads, and by examination of the results they can positively determine for themselves whether or not the claims made by the company for the performance of this washer exceed in any wise the actual facts. The Jeffrey Company have had prepared considerable literature relating to this coal-washer, its operation and the results attained with it, consisting of special catalogues and other printed matter which they will supply on request to those seeking further information.

Regrinding Check-Valves.

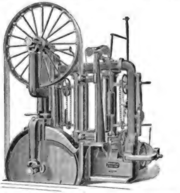
THE engravings accompanying this article illustrate a regrinding check valve manufactured by the Lunkenheimer Company, of Cincinnati, Ohio. The company has, also, branch offices at 108 Havemeyer Building, New York, and 35 Great Dover street, London. Unlike many valves on the market, this valve contains sufficient metal, well distributed, and its design is such that the opening of the disc creates a passage through the body fully equal in capacity to that of the connecting pipes.



Regrinding is performed by first removing the plug, shown in the sectional view, and unscrewing the cap of the valve; a tool then inserted through hole from which the plug has been taken engages the nick in the stud of the removable disk, by which means it can be rotated on the seat and ground to a dead fit with powdered sand and soap in the usual way. The life of the valve is thus prolonged indefinitely. The regular pattern of this check valve is designed for a working pressure of 175 pounds per square inch; but the company also makes a line of extra-heavy valves to withstand pressures as great as 350 pounds per square inch. All its valves are carefully tested and are fully warranted in every respect.

Improved Band-Resaw.

THE machine illustrated herewith is a very strong, substantial band-saw designed for both heavy and light work. It is one of an extensive line of excellent wood-working machines manufactured by the Egan Company, 212 to 232 West Front street, Cincinnati, Ohio. To adapt it to the wide range of work (it resaws 36 inches wide, 20 inches thick, or to the center of 16 inches), it has a new arrangement of feed rolls, extra heavy shafts, new straining device, and an improved arrangement of guides. The wheels are 60 inch, the blade 6 inch, and the lower wheel is solid. The main features of the design are so well shown in the cut as to render a detailed description unnecessary. The saw will not only perform the work above set forth, but will cut a thin board from the side of a 12 inch timber. The feed-rolls open to take in 8 inches on one side of the saw and 12 inches on the other side. The mandrels are of extra large size and of the best material. There are four heavily-geared feed rolls and two idlers all running in adjustable boxes controlled by two right- and left-hand screws operated by a single hand-wheel. The new straining device controlling the upper wheel and the path of the saw blade on the face of each wheel, is very sensitive and has a side adjustment as well as a forward and backward adjustment. This straining device is arranged with sectional weights and a compound lever so



sensitive that no matter what the vibrations are the strain will take up the slack in the saw blade. This is regarded as adding greatly to the smoothness and perfection of running, which, of course, insures a longer life to the saw blade. Tight and loose pulleys, 36 inches diameter and 8½ inch faces, running at a normal speed of 560 revolutions per minute, are used to drive this machine.

Coaling Warships at Sea.

THE modern warship is utterly unlike that with which even the immediately preceeding generation was familiar. In no department of engineering, with the single exception of electricity, has the march of improvement been so rapid or the innovations so great. One of the latest of these innovations is the "Temperley Transporter" for coaling vessels at sea. From an illustrated description of this device presented in *Scientific American*, April 24, a good idea can be gained of the expedition and convenience with which a warship can be coaled anywhere by this apparatus, from a barge alongside the ship, and without approach to a coaling dock, thus removing one of the previously existing limitations of the modern warship.

The article has for one of its illustrations a picture of the application of this apparatus to the coaling of the U. S. battleship Massachusetts from a barge towed abeam of the ship. The barge containing the coal to be got aboard is brought alongside and attached by lines to the ship at the proper distance from the side of the vessel to be coaled. The apparatus consists partly of an iron beam sixty feet long, attached to the crane at the side of the ship, suitably guyed fore and aft, and inclined so that the outboard end pitches downward toward the barge supplying the coal. This inclination is such that an automatically locking and unlocking carriage running on the beam runs outboard by its own gravity but is pulled inward by a hoisting rope worked by a steam winch, this one rope not only operating the carriage, but also hoisting the load to be conveyed. A suitable stop adjusted at the proper distance causes the carriage to unlock and allow the load to come down to the deck at the point desired. The coal is hoisted and conveyed in bags, an empty bag being supplied to the carriage at each outward run which is filled and returned while the contents of the last one are being stowed. This mode of getting coal on board is both rapid and cleanly. The system permits the supply of coal to ships blockading a port, instead of, as heretofore, compelling vessels of a squadron to proceed successively to coaling stations for the purpose, while the others remain on guard. The Lidgerwood Manufacturing Company, 96 Liberty street, New York, is the sole manufacturer of the Temperley Transporter, which in its various applications has proved an eminently successful invention and has come into extensive use.

Recent Installations.

THE American Engine Co., of Bound Brook, N. J., have just begun the shipment of their new direct-connected generating plants, in which the American-Ball engine is combined with their new line of six pole generators. They are now installing a 75 K.-W. Plant at No. 7 East Seventeenth street, New York, in the building of Deitsch Bros., and a 35 K.-W. plant in the building of the *Evening Wisconsin* of Milwaukee. In addition to this they have orders from the Philadelphia *Enquirer* for a 100 K.-W. plant; the Buffalo *Evening News* a 35 K.-W. plant; the Phelps's Pub. Co., of Springfield, Mass., two 35 K.-W. plants; the New York *Tribune* a 75 K.-W. plant; and the World's Dispensary Medical Assn. of Buffalo, a 25 K.-W. plant.

CATALOGUES AND TRADE PUBLICATIONS.

Continued from page 496.

The Hancock Inspirator Company, Boston, Mass.=(*a*) Illustrated descriptive catalogue of the "Hancock" locomotive inspirators and general jet apparatus. (*b*) Circular letter relating to said catalogue. (*c*) Illustrated pamphlet more specially describing the "Hancock" locomotive inspirator. (*d*) Price list of repair parts (pamphlet form), with directions for connecting and operating "Stationary" pattern inspirators. (*e*) Leaflet containing business announcement.

Pittsburg Pump Company, Pittsburg, Pa., U. S. A.=Illustrated descriptive catalogue and price-list of a line of iron, force, wood, and chain-pumps, and pump material.

American Wire Goods Company, Lowell, Mass. U. S. A.=(*a*) Catalogue of wire coat- and hat hooks, garment hangers, trousers hangers, blind fasts, bright wire goods, wire specialties, and special wire machinery. (*b*) Price list of bright iron-wire goods for cotton and woolen mills, and loom-harness makers. (*c*) Leaflet illustrating and describing the "Yorick" trousers hanger.

The Allen Anti-Rust Mfg. Co. Cincinnati, O., U. S. A.=(*a*) Folding circular setting forth how to prolong the life of an old roof at small expense, by the use of Allen's anti-rust amalgam. (*b*) Price list of Allen's anti-rust japan.

THE

ENGINEERING MAGAZINE

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THE UPBUILDING OF A MARINE CARRYING-TRADE.

By John Codman.

MR. LEWIS NIXON contributes to THE ENGINEERING MAGAZINE for January an article entitled, "Progress and Promise of American Ship-building." I have no comments to make on that part of it which applies to the navy, considering that his former connection with that service, and the subsequent knowledge he has gained as a naval ship-builder, should entitle his claim to authority; but, as an old merchant ship-master and ship-owner, I take direct issue with him concerning the mercantile marine. He introduces his subject by dating "the era of the modern metal-built steamship in this country from the laying of the keel of the George W. Clide—about 1869." At the very start he is in error. The first iron steamship built in the United States was the Bangor, constructed by Harlan & Hollingsworth, in 1844; and it is singular that, while the twin screw is generally looked upon as a modern invention, the Bangor was successfully fitted therewith, and made a creditable speed of eleven and a half knots. She was owned by the Boston & Bangor line, the superintendent of which has kindly sent me this note in answer to my inquiries:

The Bangor was the first iron steamship ever built in America. She was built at Wilmington, Del., in 1844, by Betts, Harlan & Hollingsworth, and was a twin-screw boat of two hundred and fifty tons, old measurement, rigged as a three-masted schooner. She was constructed expressly to run between Boston and Bangor. Her history, however, covers a great deal more than that circumscribed course.

On her way north from Wilmington, the Bangor called at New York to land passengers, and attracted a great deal of attention there, as she also did in Boston, the beauty of her hull being much admired by nautical experts. She had berths for eighty

passengers, and an under-deck carrying-capacity of one thousand barrels. Unfortunately, on her second trip the Bangor took fire, and was run ashore on Long island, Penobscot bay, where she was burned,—all except the iron shell of her hull. The passengers got ashore all right, with just what they stood in; but cargo and everything else went up in smoke. The steamer was afterward rebuilt at Bucksport, sold to the government, and went out to Mexico during the war between that country and the United States, her name having been changed to Scourge.

Between that time and the epoch fixed by Mr. Nixon as the beginning, this firm also built nearly one hundred iron vessels, many of which were adapted to coastwise navigation, to say nothing of those built by other firms. Still, although iron ship-building had long been successful in Great Britain, Americans, as a rule, could not be made to believe in the principle until about thirteen years after the launching of the Bangor. It was difficult to disabuse them of the idea that Noah, who built his ark of wood, was not more worthy of imitation than Harlan & Hollingsworth, who had succeeded in "floating a tea-kettle." The Pacific Mail Steamship Company went on as before, building their old-fashioned wooden-side side-wheelers. When I asked Mr. Johnson, the secretary of the company, why they did so, he replied: "Well, we are not yet satisfied that iron is better than wood, especially in the Pacific ocean, where there is a certain quality in the water that eats it up with rust." Thus the new industry dallied along with no appreciable results until 1857, when there was a sudden revival on an increasingly large scale. Harrison Loring & Co., of South Boston, then took the front rank among the American iron-ship-builders. In that year they built the Sestos, of 500 tons; in 1858–9, the Contest, of 500 tons; in 1859–60, the South Carolina and Massachusetts, each of 1,250 tons; and in 1860–61 the Merrimac and Mississippi, each of 2,000 tons,—all sea-going screw-steamers. The Pembroke, 250 tons, was built early in the sixties by another Boston firm, and sent out to China by R. B. Forbes to be employed in the coasting trade there. But even these successes do not appear to have been sufficiently convincing. As late as 1870, when the United States congress at length discovered that the national carrying-trade had been dwindling away in the fifteen years then just past, it appointed the first investigating committee to discover the cause, if possible. Mr. John Lynch, of Maine, was its chairman. That intelligent wooden-head submitted a report to the effect that American "commerce," as he called the carrying-trade, had been run off the ocean because its wooden ships had been destroyed in the United States civil war, or sold to parties abroad, and England had replaced them by her iron ships. To surmount this difficulty, he asked for a large bounty for the purpose of building more wooden ships to drive these British iron ships from the seas in their turn. Mr. Lynch was

not alone in entertaining the idea that the decadence of the American carrying-trade was entirely owing to that war, not considering that, if these wooden vessels had been of any real value, they would have been immediately replaced by their owners as soon as they had collected their insurance. The facts of the case, strange as it may seem, demonstrate that, so far as the tonnage owned at the beginning of the war was concerned, riddance of it was a positive benefit. It was a period during which iron had effectually proven its superiority to wood, and the older American vessels were either sold to underwriters, or to shippers of other nationalities, in whose docks they finally rotted. America received $15,000,000 for the Alabama claims, and was overpaid. After the war came to an end, the United States should have replaced its useless and departed wooden hulks with iron vessels, buying them for a time until the ship-builders of the country had learned to build them, as they would readily have done, just as the builders of non-prohibited railroad engines had already succeeded in establishing their home market. That was the mistake in the first place, at the instance of protected domestic ship-builders, and, at the same dictum, it has been the mistake to this day. Had that policy been adopted in the outset, as it was in Germany, the United States, like Germany, would now be building its own ships, and the free-ship advocates would not still have occasion to persevere in their arguments.

Nevertheless the war was a setback to American ship-building and the carrying-trade. During its existence, and for a long time afterward, the country was burdened by a necessarily high tariff for revenue, and by an unnecessarily high tariff for protection, both so operating together that domestic iron-ship-building, which had just taken so fair a start, was for the time being effectually squelched. When peace came, it was at first impossible to build iron ships as cheaply as they had been built before the war. There was left one of three things to do: to pay a bounty to ship-builders, to buy ships, or to be without them. As to the first, it may be said that ship-builders are no more entitled to bounties at the public's expense than are other mechanics whose business is depressed. Moreover, it has been abundantly proven that bounties and high duties are sedatives paralyzing the energies of their recipients, whereas, the nearer the approach to free trade, the more stimulus is given to emulation. Each congress since the time of Mr. Lynch, Republican as well as Democratic, has shown its wisdom in refusing to confer favors of this kind, although one came near to stultifying itself in that way, and was prevented from doing so only by the efforts of Hon. John W. Candler, a Republican ship-owner from Boston, whose knowledge of the business was convincing to his fellow-members from the interior.

Mr. Nixon says: "About all the American statesmen attempted for American ship-building during this fitful epoch was the introduction of free-ship bills in congress." On the contrary, all that these supposed statesmen attempted to do in all these years was to pass some kind of a subsidy or bounty bill for the further protection of American ship-builders. Not only were such bills reported, but they were frequently discussed in both houses, fortunately without success, notwithstanding all the money that was spent upon them. Genuine free-ship bills have never been even reported in either house. A *quasi* free-ship bill was reported by Mr. Fithian in the last Democratic congress. Its purpose was merely to admit to American registry, for service in the foreign carrying-trade only, such vessels—and there are many of them—as are indirectly owned by American citizens. Its provisions were worthless, for nothing would have been gained by the change of flag. Still, the influence of a noted American ship-builder prevented even discussion of this measure. Of the three different propositions for restoring the national carrying-trade, the country was not foolish enough to adopt the first, or wise enough to adopt the second, but, not being able to agree upon either, it has accepted the third in not additionally protecting ship-builders by giving them anything beyond the absolute monopoly they have always had, while, in refusing to further the interest of ship-owners by permitting them to own ships on the same terms as their competitors, the United States has voluntarily thrown an immense carrying-trade into the hands of other nations, stuffing into their pockets thousands of millions of dollars that might have been earned by its own people, and allowing them to raise sailors for their navies, while its native countrymen were obliged to seek employment in clam-digging or on the shoemaker's bench. Having disposed of Mr. Nixon's assertion that the era of the first modern metal-built steamship built in this country dates from 1869, and discussed some other questions following this proposition, I will barely refer to his worn-out argument that England established and maintains her ship-building by subsidies. That is simply a repetition of what Mr. David A. Wells has concisely characterized as "a historic lie." Not two per cent. of her merchant fleet have ever received a subsidy or a subvention, and, when they have received them, the government always got its *quid pro quo.* These subsidies were as available for ships built in Mr. Nixon's or Mr. Cramp's yard as for those built in the shipyards on the Clyde. They had nothing whatever to do with the furtherance of national ship-building.

We now come to the closing paragraphs of the article under consideration.

Causes already delineated have promoted the ship-building industry to a point

where, quality of output being duly considered, it can compete on even terms with any and all comers. The disparity in first cost between American- and British-built ships of like classes has been so nearly eliminated by our recent phenomenal progress in the art, notwithstanding our higher wages, that it has ceased to be an important factor in the situation. Merchant and steamship companies can now, all things considered, procure American-built ships as economically as ships of English build. This, of course, refers to the higher classifications. Hence the American ship-builder is ready to do his share towards resurrection of our sea-going merchant marine on the most favorable footing. But, as yet, the disparity between this country and England in the matter of cost of operating ships of like classes exists in full force,—in sufficient force to be practically prohibitory. For this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owner. This is not because the American ship-owner does not desire new ships, but because, under existing conditions of competition with rivals receiving substantial aid from their respective countries, he could not operate them profitably if he had them.

Thus the reader will perceive that, no matter from what point of view the situation is surveyed, or no matter at what admitted point of fact the train of reasoning may begin, the conclusion arrived at is always the same,—namely, that the future of American ship-building in any large sense depends upon the future of American traffic over sea; and that the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy.

The "causes already delineated" are the demands of the navy for ship-yards which would not otherwise have been put in operation,—the very causes to which he erroneously attributes the first impetus to British iron-ship-building for the merchant marine. Herein is another of his mistakes. Long before an admiralty order was given to the British iron ship-builders they had turned out for their own countrymen, and for all people excepting Americans, who still adhered to their wooden ships and restrictive navigation laws, iron steamships and sailing ships that had appropriated the carrying-trade of the world while we were looking on. It was because they had these magnificent plants already that the government availed itself of them. The condition of things in the two countries is precisely reversed. In Great Britain the government makes use of what were from the beginning merchant-ship-yards, and which would survive and flourish without the aid of the State. In America, it seems, merchant ships can be built only in government shipyards, and, in order to build more merchantmen, the country must continue to build ships for the navy, whether they are needed or not, to make these ship-yards remunerative. However that may be, Mr. Nixon insists that American ships can be built as cheaply as English ships, especially "those of higher classifications." In the latter assumption he is more nearly correct than in his general statements; but he is not correct in either. It was not long ago that the steamship China was built for the Pacific Mail Steamship Company. Her net tonnage was 2,400 tons. Mr. Gould, the president of the company, showed me the specifications that were laid before the Ameri-

can ship-building firms. The lowest bid he could get from them was $168,000 above that of the Scottish firm which finally contracted for her. She is surely a ship of the higher classification—far superior to any other on the line. It is cheaper to own her under the British flag without a subsidy than under the American flag with one.

Mr. Chamberlain, the late commissioner of navigation, estimates the average difference in cost between British and American steel vessels at 25 per cent.—in favor of the former. Mr. Dodsworth, the editor of the New York *Journal of Commerce*, has a reputation as a statistician equal to that of David A. Wells or Edward Atkinson, and has made a special study of this question. He tells me that Mr. Chamberlain has underestimated the average. He admits that for passenger ships it may be even less, because American cabinet-makers and upholsterers are greater adepts in their arts than are British mechanics in the same line, and use machinery more extensively for that purpose. On the other hand, it is not generally realized by those who discuss the matter that the most profitable part of the ocean carrying trade is prosecuted by "tramps," roughly, though strongly, built, with no cabin accommodations beyond those required by the captain and officers. He estimates the cost of some of this class of vessels as 40 per cent. less than that for which American ship-builders are willing to supply them. Then there are intermediate classes of ships, built mostly for freight, but with limited passenger accommodations, on which the difference of cost should be calculated accordingly. I am inclined to give credit to such testimony as this, which fully corresponds with all other disinterested statements that I have been able to collect. It is not true that "the American ship-builder is ready to do his share towards the resurrection of our sea-going marine on the most profitable footing." Were it so, he would prove by actual demonstration that Mr. Chamberlain and Mr. Dodsworth are incorrect in their calculations. Nor is it true that "the disparity between this country and England in the matter of operating ships of like classes exists in full force—in sufficient force to be practically prohibitory," and that "for this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owners." To say nothing of hundreds of "tramps" owned and commanded by Americans, but forced by the laws of their country to sail under foreign flags, several of the large cargo and passenger ships of what is called the International or American line are likewise thus owned, and they are all profitably sailed. Otherwise they would not exist. Bear in mind that such vessels are debarred from the coasting trade, which sometimes might be very convenient for them. Would it cost any more to sail them if

they were built of American instead of British iron, and if they had American instead of British ensigns at their peaks? If the cost of building were the same, would not their owners have them built in the United States, in view of the great advantage they would derive from liberty to participate in the coasting trade? I quite agree with Mr. Nixon that "the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy." It is unfortunately true, as it is true that it has been so in all the years back; and it is still more unfortunately true that American national statecraft and diplomacy have been, and still are, controlled by the selfish policy of individual ship-builders.

In conclusion, although I have said enough already to indicate my belief that free ships are the only means for promoting ship-owning and ship-building, I have never advocated their admission to the flag under any conditions that would imperil the general interests of the coasting trade.

From the beginning of the discussion when I appeared before the Lynch committee in 1870 (although the chairman refused to incorporate in his report any remarks made by free-ship advocates) my proposition has been simply this: "Full American registers, for all vessels of over three thousand tons, wherever built."

This would not give all that might be desired, but, while it would not interfere with the interests of domestic ship-builders, but, on the contrary, would bring repairing business to their yards, it would permit the United States to engage in the great trans-atlantic traffic on equal terms with other nations, and, by gradually leading to the imitation and reproduction of such ships at home, would eventually bring down the cost of all ship-building, so that the great object of equalizing it with that of foreign countries would be accomplished.

I have no doubt that, if congress had listened to this suggestion twenty-seven years ago, the American mercantile marine would by this time have nearly equalled in tonnage that of Great Britain, and that the United States would have saved thousands of millions of dollars that have been needlessly paid to European ship-owners in freight-money.

"It is never too late to mend." Let the United States now do what it should have done long ago.

THE PARIS FIRE AND THE BUILDING OF TEMPORARY STRUCTURES.

By H. Heathcote Statham.

THE terrible disaster in the Rue Jean-Goujon at Paris is of a nature to set us all thinking as to the dangers that we run from the combination of fire and panic in crowded buildings, and the best means of rendering such disasters impossible in the future. It is true that in a certain sense the fire was an exceptional one in its circumstances and in regard to the nature of the building in which it occurred. The construction of the building (if it can be called a building) was such as to render it almost as good a subject for conflagration as if it had been specially prepared for that purpose; and its plan and arrangement, and the nature of the crowd collected in it, afforded, unhappily, the best, or worst, possible conditions for a panic. In these respects the catastrophe may be considered to have been a much less typical one than the ordinary run of theater and public-ball conflagrations, and it might be argued that for that reason it is less instructive as a warning, or as an event from which to deduce practical conclusions; which would be true in a sense. But in another sense the exceptional circumstances of the fire give it a special significance. It forms one of those terrible surprises that fire is always springing upon us as a reminder that we have overlooked a forgotten something. We have in recent days spent a good deal of trouble in rendering our permanent buildings fire-resisting, and in providing adequate means of exit; and we are prone to sit down and reflect that we have done the work well, and, as far as human forethought can provide, have exorcised the fire-demon. Suddenly he starts up in a new form, and reads us the tragic, but not unneeded, lesson: "You have forgotton your temporary structures!"

It is to be hoped, certainly, that not many even among temporary structures are so laid out for fire and panic to do their worst as was the ill-fated bazaar booth at Paris. Yet we cannot be sure even of that. When temporary structures are erected for public enjoyment or public business, as long as all goes right little attention is paid to the construction or materials employed; people have plenty else to think about. Yet there may have been scores of temporary erections set up, and crowded for a day, or for a few days, which, if accidentally set on fire, would have led to almost as dreadful results as those which have horrified us at Paris. They have escaped, and nothing more has been

thought about them or the terrible dangers which lurked in them. At last a catastrophe has come, and people are as astonished and horrified as if no such thing were to be expected.

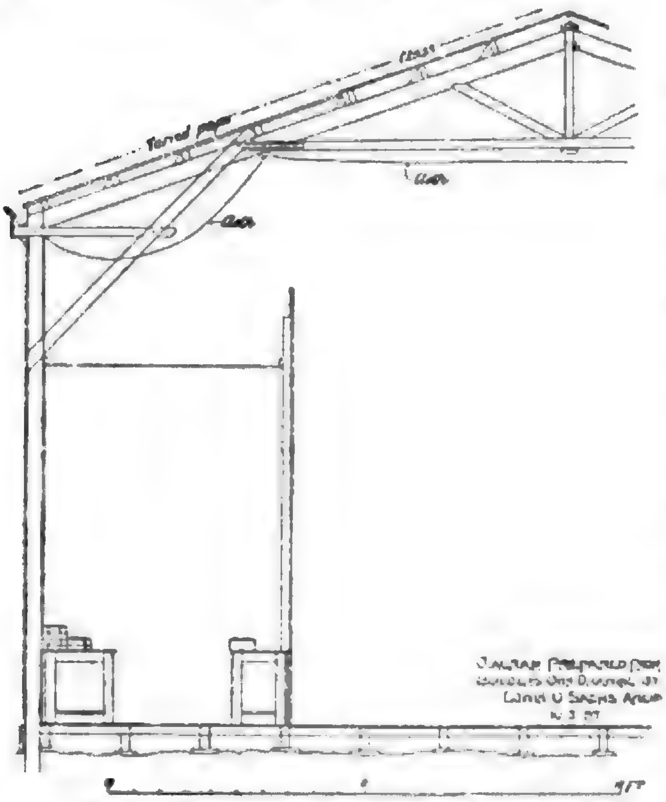


FIG. I. SECTION OF THE PARIS BAZAAR.

The section (Fig. 1) of the Paris bazaar will show, however, conclusively enough, that nothing was wanting to prepare for a conflagration. The building was erected, under apparently no superior supervision, by a Paris firm of contractors who had been largely employed in the provision of temporary decorations in the streets for special *fêtes*, and who therefore must have acquired a habit of erecting flimsy structures. It is stated that they were anxious, for charitable reasons, to put the building up as cheaply as possible; or (more probably) they were urged to do this by the promoters of the undertaking, who did not wish to devote more money than necessary to a portion of the project which would produce on return. Under these circumstances, naturally, no extra expense was incurred in seeking for special and noninflammable materials. That which was cheapest and most readily procured was used. The roof was covered with tarred paper; and beneath the glazed skylights a cloth velarium was loosely draped, with plenty of air-space between it and the roof. The walls were formed of wooden posts with very thin boarding (about half-inch) nailed on

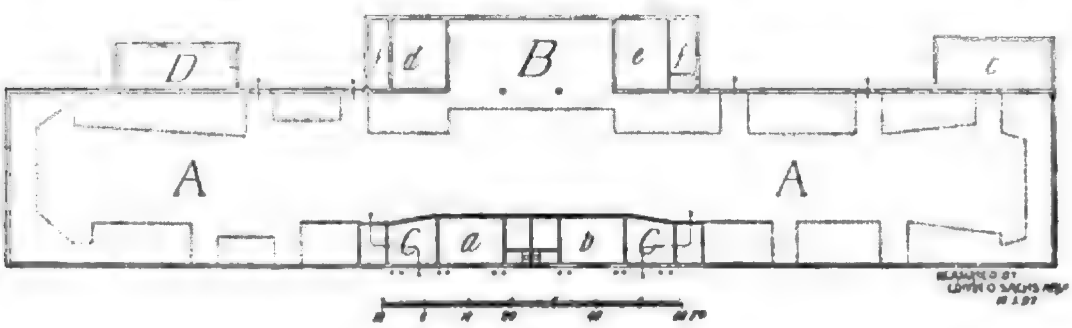


FIG. 2. PLAN OF THE PARIS BAZAAR.

them. It would be hardly possible to erect anything which would more readily catch and spread fire.

The plan (Fig. 2) shows how completely the building was arranged so as to form a trap in case of any panic and hurried attempt at escape. The following are the references to the letters on the plan :

A—Gallery.
B—Buffet.
C—Lobbies in connection with main entrances.
D—Cinematographe room.

a—office.	d—buffet-store.
b—cloak-room.	e—office.
c—store.	f—stores.

The principal doors, at C, are arranged in the worst possible way for a hurried exit, two turns having to be made to get out (the object of this having been to exclude draughts). The dotted lines represent the stalls and counters. The two ends of the enclosure are *cul-de-sacs.* The fire began in the cinematographe room, D, and almost immediately spread into the main enclosure, being greatly assisted in this by the velarium, which caught fire and began to blaze at once. The crowd naturally fled toward that part of the building which, in the plan here given, lies at the right. Those who made for the main entrances naturally pressed toward the right-hand one (on the plan), the one furthest from the origin of the fire. Many rushed towards the extreme end of the enclosure, and numbers thronged and struggled through the cloak-room door, taking it in their panic for an exit. The two extra doors, between that and the buffet (marked with arrows on the plan),were apparently unknown to them, and were perhaps concealed to some extent by articles on sale ; at all events, no one seems to have known of them. The melted tar from the roof—the glass having broken with the heat—dropped, and pieces of the burning velarium also, setting fire to the dresses of the ladies who composed the main portion of the crowd. Thus all things concurred towards the rapid spread of the fire and the multiplication of circumstances calculated to increase the general terror and confusion. The fact that nearly all the crowd were women told against them in a double sense. Their dresses more easily caught fire ; and they had not sufficient strength to break through the side walls, which, I am assured by an architect who had examined the remains of the structure, were so flimsy that a few resolute and strong men could easily have broken through them at any part. Probably both men and women were too dazed with fright even to think of such a thing. It is sometimes said, and said very truly, that the people in a building would always have time to escape after an alarm of fire, if they could only keep their

heads and go out in an orderly and systematic manner. But in the present case there was hardly time for that, if the presence of mind had been there to organize the retreat. So inflammable was the building in every direction that the whole thing seems to have been practically over in a few minutes.

Such are the main circumstances of this heart-rending disaster, one of the greatest public calamities that has overtaken any modern city in recent times. And now what are we to say as to the lesson to be drawn from it? Confining ourselves, in the first place, to the immediate subject,—that of temporary structures,—it seems imperative that all such structures should be placed under official control and inspection, just as much as the most important permanent building. The temporary building may have to be in use for only a few days; it may in some cases be in use for only one day; but on that one day the disaster may arise, and the consequences may be as tragical as in the case of the burning of a permanent theatre. And the fact is that in most cases temporary structures are much more dangerous than permanent ones; they may be, and commonly are, quite as difficult to get out of, while they are almost certain, as usually constructed, to burn much quicker and have less time for exit. It appears that in Paris any contractor who receives the order may erect such a structure as this bazaar building, of the most inflammable materials he finds it convenient to employ, and on any plan he likes, without rendering himself subject to any official inspection or to any fine for evading regulations. It is clear that this must be so, because every one who knows the French passion for red tape and for enforcing regulations, where they exist, even without necessity and to the great inconvenience of individuals, will know that no French official would have let pass the opportunity for pouncing on a builder who had evaded any legal conditions. The first thing the French will have to do, and no doubt will do, will be to pass enactments regulating the construction of temporary erections and subjecting them to official inspection. It is sad that they should have needed so terrible a fatality to rouse them to a perception of the importance of such regulaions; but it can hardly be supposed that they will be any longer blind to it.

London is not so behindhand. Section 84 of the London building act provides that no person shall set up any wooden structure (except hoardings not exceeding twelve feet in height) without a special license from the county council; and, while there are no special structural conditions laid down (which would be hardly possible for a class of structures likely to be varied and abnormal in character), there is no doubt that the architect of the council would exercise a considerable discretion as to the buildings which he would warrant, especially if for

any public use which would lead to their being crowded with people; and I think it may safely be assumed that such an erection as that in the Rue Jean-Goujon would not have been allowed in London for such a purpose. What degree of control of such structures is provided for in American State or city building laws I am not aware.

Assuming the existence of official control over temporary structures, what are to be its demands? We cannot demand the same monumental structure of brick, stone, or terra-cotta which is required by the usual building-act rules (in England, at all events) for public buildings; they would then cease to be temporary structures. But we ought to require that they should be constructed of fire resisting materials; of materials which, if not uninflammable, at least are such as to catch fire with difficulty and burn slowly. All such stuff as the "tarred paper" which covered the Paris building would, of course, be rigidly prohibited. Wood in thin sections should be prohibited; where a thin filling is required between uprights, there are plenty of incumbustible substances to be had now, in the nature of fibrous plaster slabs, concrete slabs, etc., which can supply the place of the match-boarding without presenting, like that, an expanse of fuel. Whether iron should be insisted on for the main upright supports is perhaps a question. It is somewhat difficult to treat vertical iron supports as a part of a temporary structure; they mean a good deal of additional expense, and a more elaborate foundation than a timber upright requires; and it must be remembered that a hard-wood post of substantial thickness is really more fire-resisting, as facts have proved over and over again, than an iron column; it may catch fire to a certain extent, while the iron column or standard will not; but it will only char slowly, and it will retain the greater portion of its strength long after a wrought-iron or cast-iron column will have bent and twisted with the heat, and let the floor or roof down. On the other hand, a light iron roof, with the principal connected by a shoe with the head of the hard-wood upright, would be preferable to a timber-framed roof, which must necessarily include a certain amount of rather light wood, likely to add to a conflagration. Any hangings or cloths used in the decoration or covering of any portion of the structure should be made of non-inflammable materials, of which there is now a considerable choice; the expense may be a little greater in the first instance, but what is that compared with security from fire? If the promoters of a temporary building are unwilling to go to this expense, it should be the business of the official authority to compel them to do so.

In addition to the question of material comes the question of plan and arrangement of exits. In a structure of a temporary character it is generally very easy to arrange plenty of exits, it being usually a

structure of very simple plan and with few or no accessory apartments. In more complicated permanent structures the provision of a sufficient number of emergency exits is often rendered somewhat difficult by the fact that the main apartment—as is often the case in a town hall—is surrounded by subsidiary rooms and passages which lie in the way of a direct exit. But in a temporary structure there is, in general, none of this complication of plan, and it should be easy to have exits in nearly all directions. What is important is that these exits should be easily recognizable. There is where one of the aggravating causes of the Paris disaster came in. The two exits known to all the people (those at C, Figure 2), and by which they had entered the building, though very suitable as entrances, were hampered as exits by the vestibules and by the right-angled course which had to be taken between the inner and outer doors. The exit doors at the other side (indicated by the arrows) were apparently not known to any one, were not immediately recognizable as doors, and were not marked "exit," as they should have been. But perhaps the worst point of all about the plan of the building was the fact that each end of it was a *cul-de-sac.* When a crowd in a panic flies in a particular direction supposed to be the farthest from the danger, it will always press as far as possible in that direction, and a crowd which has thus thronged up to the end of a building and finds no door there is lost; it cannot move back again in consequence of the pressure of those who are still making for the extremity of the space, having not yet discovered their mistake. Therefore, one of the most fatal features in the plan of the Paris building was these two dead-ends.

There remains the question of interior fitting and furnishing, in which it is sometimes difficult to avoid the aggregation of a considerable amount of inflammable material. In a temporary building in which the floor is at all raised from the ground, it is difficult to have anything else than a wooden floor, unless we are pre-supposing a more monumental form of wall-construction than can generally belong to a temporary building. As regards danger from fire, thick planks laid on the flat, with sufficient supports at intervals, are safer than a joisted floor with a thin boarding laid on the joists; if any cause of fire arises under the floor, the thick planks are much less likely to catch it, and much slower in blazing up, than the ordinary thin flooring boards would be. One has only to consider the case of ground floors, or floors raised two or three feet from the ground with a space under them; for in a temporary structure upper floors are hardly practicable.

There is, lastly, the material collected in the building in connection with the purpose for which it was erected. If it is a building for

some kind of festival or ceremonial, the principal combustible material will be benches and chairs; if it is for a sale, or bazaar, or exhibition of work, we shall have few or none of these, but a great collection of wooden stalls and, probably, combustible textiles; and with these we can do nothing except take precautions not to allow them to catch fire; they are not part of the building, and no legal regulations can touch them.

Having got our temporary structure into a condition offering as great a resistance to fire, or as little liability to it, as can be attained in that class of building, we have then to guard against the causes which lead to the outbreak of fire. These, in almost all cases, are to be traced to one of two forms of carelessness or blundering: it is either the misuse of a lamp, or its overturning; or it is the culpable carelessness of throwing down lighted matches or lighted paper in the building. The latter cause is almost invariably connected with smoking, and so many fires have begun from this cause that in all temporary structures smoking should be strictly prohibited. The means of lighting have been the cause of many fires; a long list of theater fires is traceable to this cause—the overturning of a lamp in one of the actors' dressing-rooms, the catching of a bit of scenery by an inadequately-guarded gas-jet, and so on. The theater-fires which originate behind the scenes (as most theater fires do) may be not improperly classed with fires in temporary structures; since, though the outer enclosing walls are of solid material, the stage itself and its accessories are very much in the condition of a temporary structure, filled with light materials which ought to be rendered uninflammable, but often are not. It is probable that the increasing prevalence of electric lighting, though it has occasionally been the cause of fire, will in the end very much diminish the list of fires arising from the means used for lighting. The Paris fire almost undoubtedly arose in the first instance from some accident with the cinematographe light, but exactly what it was we shall probably never know now.

Besides the temporary buildings which are really temporary,—that is, put up for only a few days or a few weeks, there is a class of what may be called permanent temporary buildings,—that is, buildings erected in a comparatively slight and unmonumental manner, but, owing to circumstances, allowed to remain in existence and in use for an indefinite period. This class of buildings consists mainly of those which are connected with shows, panoramas, and exhibitions of various kinds; structures which will be taken down eventually, but which may remain in use for a year, or two years, or more. These are often more dangerous than the "temporary structure" properly so called;

the people in charge, as well as the audiences, get reckless about them, get used to thinking of them and treating them as solid buildings; and they almost always have hollow and dark corners in them, in which all kinds of rubbish, sometimes inflammable, accumulates. And this remark serves to remind one that, of all things in temporary structures which are to be avoided as danger-traps, are hollow spaces under a boarded framing,—beneath a rising gallery of seats, for instance. One does not know what may be there; and the careless (might one not say criminal?) dropping of a lighted match or bit of paper through some opening in the floor of the seating may set everything in a blaze in an almost incredibly short time. Therefore, in temporary structures avoid all hollow spaces which cannot be easily seen or got at.

The subject of the safety of temporary structures is of great practical importance in these days of international and national exhibitions, where so many elaborate erections are raised which, in general, have the forms of monumental architecture without the power thereof. The subject will probably come home to the minds of American readers, for Chicago has left its mark behind it, and there are likely to be many minor, but still important, exhibitions with similar buildings. It is to be hoped that they will be so constructed and planned as to afford the least possible chance of fire, and, in case of it, to leave the audience time to retreat with safety and in order.

One word on this subject of orderly retreat from a building on fire. It does not apply to the recent Paris fire, where, for a large proportion of those present, even presence of mind would have done nothing, the conflagration being so sudden. But in all cases where the building offers a decent amount of resistance to the fire, there is no doubt that any audience might walk out in a few minutes and in perfect safety, if they would only bear in mind the military principle of preserving a definite order in their movements. To walk, for instance, two and two in line, without hurry but in a regular ordered step, is the way a large body of men can be got through a small door in two or three minutes time, without struggle or confusion. The same system is just as available to get an audience through a theater door in two or three minutes, if only they keep their heads sufficiently to carry it out, and if the cool-headed among them will guide and direct the others. Many lamentable and perfectly unnecessary catastrophes from panic would have been avoided by this simple means.

CHARACTERISTIC AMERICAN METAL MINES.

THE ANACONDA COPPER MINE AND WORKS.

By Titus Ulke.

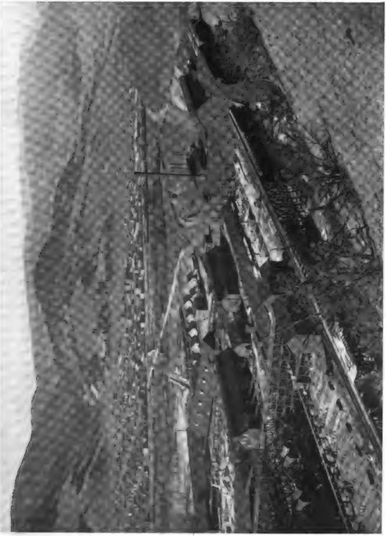
THE famous Anaconda group of mines, located near Butte, Montana, on the western slope of the main divide of the Rocky mountains, is now the largest copper-producer in the world. Last year its output, reduced to metal, was more than one hundred and twenty-five million pounds of copper, and about five and a half million ounces of silver, besides seventeen thousand ounces of gold. Together with the Anaconda reduction works, it furnishes an admirable example of the highest development of mining and metallurgical practice, and of a far-seeing and wise business management.

The discovery of placer gold in the valleys near Butte in the sixties first attracted attention to this district. When the placers were worked out, prospectors turned their attention to silver mining, and soon discovered the great wide lode on which the Anaconda was located. Dark red and brown quartz, carrying oxids of iron, horn silver, and gold, with only traces of native copper, and very limited occurrences of copper oxid, formed the outcrop of this lode. The vein was richer on the summit of the hills it intersected than on their flanks and in the valleys.

A number of silver mills were started soon after the above discovery, which profitably treated the oxidized surface ores by the usual method of pan amalgamation. No one then dreamed of the tremendous quantities of copper ore soon to be revealed.

The Anaconda was bought as a silver mine about this time, and preparations were being made to mill the ore, when in 1882 the main shaft, sunk to a depth of about three hundred feet, entered the rich copper zone. This copper, leached out of the first three or four hundred feet (in depth) of the vein, or down to the water-line, had been concentrated in the underlying ore, and had thus produced a zone of rich secondary copper ore two hundred to four hundred feet deep, which contained thrice the normal copper contents of the lode below.

In the decuprified surface ore silver was retained as an insoluble chlorid when the soluble copper was removed. The proportion of silver to copper in the enriched copper zone, which contained an excess of copper, was naturally found to be less than in the unaltered ore beneath. Hence the proportion of silver to copper gradually increased with the depth. No massive carbonates were discovered in the Anaconda, or in the other mines situated on the same lode; but

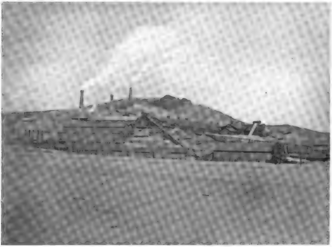


UPPER WORKS AND ANACONDA, FROM ABOVE HIGH LINE.

PANORAMA OF CARROLL AND THE LOWER WORKS.

the neighboring Gagnon and Parrot mines, in their early days, yielded small quantities of an earthy carbonate of copper, rich in silver. The altered ores of the great lode and of the smaller cross and parallel lodes consisted mainly of a compact purple ore, sometimes carrying considerable native silver, and of soft black sulphurets.

The copper-bearing ores are sulphids (chalcocite, pyrite, bornite, and chalco-pyrite), often grading into each other, and found in a series of strong fissure veins in a basic pre-Cambrian granite, which is almost a diorite in composition. The veins form a system of more or less parallel fractures, which originally afforded channels for the copper-bearing solutions, from which the ores were evidently deposited in the interstices and as a replacement of the minerals composing the granite. A later eruption of porphyry (rhyolite), cutting through the granite, appears to have influenced the ore deposition.


GENERAL VIEW OF THE LOWER WORKS.

The lodes generally have an east and west strike, and an average dip of some twelve degrees to the south from the vertical, though in places this becomes as much as forty-five degrees. The distribution of the ore is very irregular, extensive bodies being frequently found on breaking through what appears to be a well-defined wall. Frequently there is no definite line between the vein and the adjacent country rock. The ore is usually found in chutes, many of which extend several hundred feet along the strike before pinching out.

PANORAMA OF ANACONDA AND THE SMELTERS.

Their depth is frequently even greater than their length, though they are sometimes broken by small faults. The veins are rarely banded, and vary in size from a few inches of compact ore up to a hundred feet or more, as in the main Anaconda shaft. Twelve feet may be regarded as the ordinary width, though a large proportion of the ore raised comes from stopes thirty or forty feet wide.

The gangue rock is usually a decomposed, coarse-grained granite. Besides copper glance, iron pyrite is usually present in considerable amount, but it carries little copper or silver.

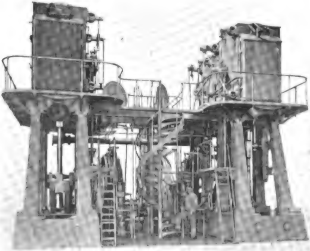
At a depth exceeding thirteen hundred feet, there is no sign of any weakening or giving out of the copper lodes; so that the present enormous output can be maintained, it is claimed, for at least ten years longer. In 1895 the copper output of Butte was about 195,000,000 pounds of fine copper, of which the Anaconda contributed considerably more than half. It seems hardly credible that this tremendous production came from a little granitic area not over two miles long by one mile wide.

The ore raised from the mines of the Anaconda Copper Mining Company, including those of the Chambers syndicate, was formerly much richer than at present, and now averages only 6½ per cent. of copper and 7 ounces of silver per ton. There is a loss of about 18 per cent. in concentration and nearly 5 per cent. in smelting and refining, which further reduces the yield of the ore to about 5 per cent. of copper and 5 ounces of silver. However, notwithstanding this great decline in percentage and value of the ore treated (which, to be sure,

has resulted partly from the ability to work lower-grade ores to advantage), the Anaconda mines are making more profit to-day from a six-per-cent. ore than formerly from an ore twice as rich. This results from the consolidation of mining properties, and from the astounding and radical improvements in the metallurgical treatment of the ore. The rich surface ores of the Butte district have furnished the capital needed to design and construct the improved plants, and to gain the experience necessary for treating the lower-grade ores at a profit.

The shaft house of the Anaconda mine crowns the summit of a ridge near Butte, so that there is ample dumping-ground for whatever waste rock it may be necessary to hoist. But little waste is raised to the surface, however, as it is a handy material for filling the large cavities left by the wide stopes, which can be but temporarily held open by even the best timbering.

The shaft, which is vertical and now over fourteen hundred feet deep, comprises two hoisting compartments and one pump-way. It is about 9 feet by 18 feet in the clear, furnished with wall plates and lined with timber 12 inches by 12, end and counter pieces being 12 inches by 14. This allows two cars to be placed end to end on each deck of the cage. The winding drums are driven by two enormous compound hoisting engines, supplied with steam from a large battery of boilers.



THE HOISTING-ENGINE "MODOC."

Nearly all the timber used in the mine is squared and sawed above ground, so as to reduce to a minimum delay in erecting timber sets in the workings. Levels are driven from the shaft every hundred feet, and a cross-cut twenty-five hundred feet long connects the Anaconda with High Ore Shaft No. 1. Wherever proper appliances have been introduced, natural ventilation alone suffices to keep the air in perfectly good condition. This fact, and the further circumstance that no serious amounts of water have thus far been encountered, considerably enhance the value of the veins.

The method and extent of stoping varies according to the nature of the lodes. As these in many places have no defined walls, the only distinction between veins and country rock is a commercial one, based on shipping value. Even in large ore chutes, frequent prospecting by foot and hanging wall cross-cuts must be practised, to develop the small bodies that branch off into the walls at intervals, as well as to furnish waste to fill the large cavities left by the wide stoping.

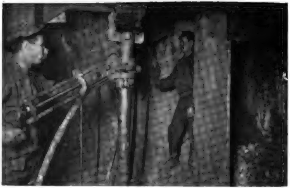
FRAMING TIMBER FOR THE MINE.

Square timber sets of the usual construction are used in the workings. It is scarcely necessary to state that stopes of great width do not imply solid ore bodies of equal width.

The waste, chiefly decomposed granite, commonly forms twenty-five per cent. of the entire material stoped,—sometimes much more.

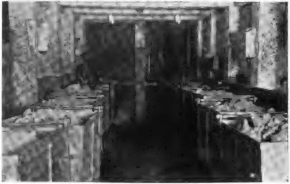
The magnitude of the Anaconda Copper Mining Company's operations can be measured when one considers that it spent $2,000,000 in

East sill floor breast. Miners at work.



Drilling the ore.

Miners in the breast filling-ore cars.



Station loaded with ore-cars, ready for hoisting.

SCENES FROM THE UNDERGROUND WORKINGS OF THE ANACONDA MINES.

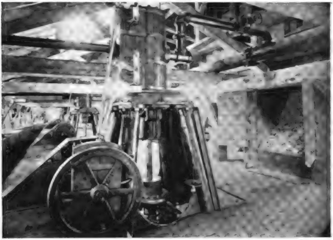
new machinery, hoisting engines, air compressors, etc., during 1896, besides paying a dividend of $2,250,000. The daily output of ore is more than three thousand tons, and the number of employees in and around the mine is two thousand.

The ore is loaded on cars holding about twenty tons each, and is shipped for concentration and reduction to the Anaconda Works, twenty-seven miles from Butte, at Anaconda, and comprising two immense concentrating mills, smelting works, converter plants, and the largest electrolytic refinery in the world. As these works are conveniently located in terraces on the slope of a long hill, near the top of which the railroad passes, the ore can be dumped directly from the cars into enormous bins placed above the two concentrators. High-grade ore not requiring concentration is sent directly to the roasting or smelting furnaces.

ANOTHER HOISTING ENGINE.

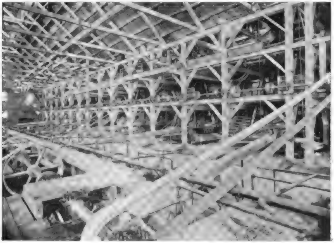
At the Lower Works concentrator the ore from the bins is fed over iron-bar screens called "grizzlies" (with spaces one inch wide between the bars), and then under massive steam stamps. Very large lumps of ore are broken on the grizzlies with sledges. The fines passing through each grizzly are fed into a revolving screen, which sizes the material and drops it into launders, or troughs through which water flows to feed the jigs or piston-machines for separating the barren rock from the ore.

Six steam stamps crush between eighty and ninety-five carloads of

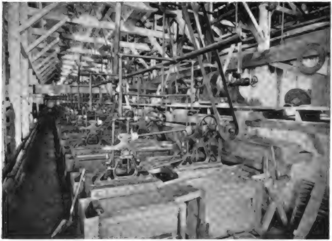


UPPER STAMP FLOOR AT THE UPPER WORKS.

ore of twenty tons each, daily. The crushing capacity of each stamp, therefore, reaches the enormous total of two hundred and eighty to three hundred tons, thus equaling the capacity of seventy to one



PERSPECTIVE VIEW OF STAMP FLOORS, UPPER WORKS.



JIGS AT THE LOWER WORKS.

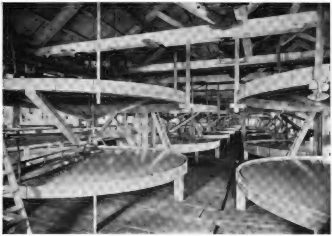
hundred California stamps, or of three hundred Cornish stamps,—certainly a very remarkable fact. The weight of each stamp shoe alone is one quarter of a ton, and of the stem with shoe, etc., one and a

ROUND JIGS, LOWER WORKS.

half tons, the crushing weight being thirty tons. A shoe lasts only three days when the stamp is run to full capacity. The stamped ore is sized in hydraulic separators, and is then fed into Collom jigs.

The order of concentration appears from the fact that the middles, or medium-sized product, from each set of eight Collom jigs go to two round jigs, the middles from these to a pulverizing mill, and the product of the latter to finishing jigs, which separate from the ore the last traces of adhering barren rock. The jigs, of course, are automatic in action. They give little trouble, excepting that caused by the breaking of their springs, which have to be replaced rather frequently.

To treat the fines, two sets of eight double-decked round tables are employed, together with slime pits. The loss of copper and silver in sliming is heavy, but cannot well be prevented, except by rejecting the otherwise economical steam stamps, and substituting crushing machinery giving a product more uniform in size.



ROUND TABLES, LOWER WORKS.

The various concentrates from the jigs, tables, and slime pits are roasted, at a low cost, in batteries of revolving roasters of the Brückner type. The one hundred and fifty-six Brückner furnaces employed at Anaconda are of two sizes, the larger having a cylinder 8½ feet in diameter and 18½ feet long. The front end of the cylinder is contracted to register with the throat of a movable fire-box, while the other end opens into a dust-chamber. The movable fire place is attached to

THE BRÜCKNER ROASTERS, LOWER WORKS.

the cylinder until the charge is ignited, and then removed, and is reattached only to complete the roast.

From 9 to 13 tons of concentrates, inserted in one charge, are roasted every 24 hours, from 36 per cent. of sulphur down to 8 per cent., with a consumption of 1 ton of Rock Spring (Wyoming) lignite. The roasted material is then discharged, red-hot, into hoppers suspended above the matting furnaces. These are reverberatory furnaces capable of smelting or "matting" eight to ten charges of 4.8 tons each (6 cars holding 1,600 pounds of roasted ore) in 24 hours. A little lime is added to each charge, as it reduces the percentage of copper lost in the slag.

The coal is fed from a hopper into the fire-box, and the ashes are sluiced out of the hopper-shaped ashpit by a current of water. The grates are shaken by an outside handle. The air used for combustion is preheated in a chamber surrounding the stack, passes backward and forward through the main vault under the furnace, and finally reaches the firebox at a temperature of 700° F. By this ingenious preheating arrangement, as much as 46 tons of calcines, or roasted ore, can easily be matted daily on a hearth only 10 × 20 feet in size.

The slag is discharged from a pair of furnaces into a mutual catch-spout, and into a sluice supplied with sufficient water to carry the slag to the dump. As the furnaces are built in a long row, they have a common main dust-chamber, or flue, into which each furnace flue

opens. The main flue discharges into a stack with powerful draft located on the top of the hill.

The product of the reverberatories is a matte, carrying sixty to seventy ounces of silver, and approximating the following composition: 62.5 per cent. of copper, 11.6 per cent. of iron, 0.4 per cent. of lead, 19.2 per cent. of sulphur, and 0.2 per cent. of silica. This matte is sent to the converting house, or bessemer plant, for conversion into bessemer copper. There are two bessemer plants at Anaconda,—one near the Lower Works three miles from Anaconda, and the other and older plant, which we will briefly describe, nearer town.

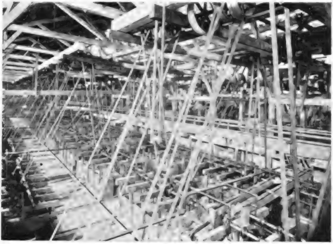
At the time of my inspection (1893) nine converters arranged in a battery were in operation. On a higher level, just above this battery, are three cupola furnaces, into which the matte is charged. The matte, heated to a temperature of about 1,400° F. in the cupola, is tapped out and run through movable troughs lined with fire clay, into the particular converter ready for charging. Each converter holds from one and one half to two and a quarter tons of matte.

THE CONVERTING ROOM.

After charging the converter, the metal stream from the cupola is stopped, and the converter blast, used to burn off or oxidize the impurities in the copper matte and supplied from blowers through four tuyeres at the back and three at each side of the converter, is turned on. In about twenty-five minutes after charging, the copper in the converter is skimmed. When this operation is finished, a little cold matte is added, and the blast continued until the charge is "cooked," or done. Then the converter is swung over, and its contents—now nearly pure copper—are poured into ingot molds, holding about 220 pounds of copper each. At every conversion or melting, from twelve to twenty-one bars are cast. Generally from one and a half to two hours are consumed between the time of filling and the time of tapping the converter. After twelve hours,—*i. e.*, six charges,—the converter is cooled by running water from a three-inch hose into it, and also over the iron shell, the cooling taking about three hours. Then a man gets inside, and relines the converter with good quartz, to which a little fire-clay is added. This takes from one half to three quarters of an hour. The thickness of the relining averages three inches, so that the total thickness of the lining at new charging is about nine inches.

Before the new bessemer plant was put into blast, two kinds of converters were used: converters with straight tops, in which the bottom plates are easier to repair, because each converter can be entirely

INTERIOR OF NEW FURNACE BUILDING, FROM WEST END.



PERSPECTIVE VIEW OF THE HART JIGS.

revolved on its trunions, and old-style, square converters, with tops curved over, which reduce the danger to workmen from flying pieces of slag. At the new plant larger converters, 10×6 feet in outside height and diameter, having 16 tuyeres, and weighing 11 tons with shell and lining, are employed. A blast pressure of 13 pounds per square inch is used, and 12 blows are made per 24 hours. Although the initial charge is only 3½ tons, a charge of as much as 8½ tons of matte can be treated economically in these new converters.

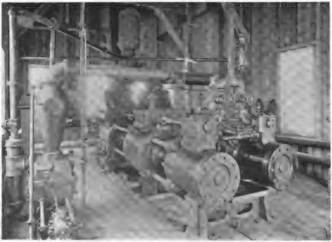
The ingots of bessemer copper, averaging 99 per cent. copper, and 100 ounces of silver per ton, are sent to reverberatory furnaces, to be melted and cast into flat plates (anodes) for electrolytic refining.

The object of electrolytic refining is two fold: first, the making of pure copper of high electrical conductivity; second, the extraction of the gold and silver contained in the crude copper. This work is accomplished at Anaconda in an enormous refinery built on the flat between the Upper and Lower Works.

Although the Anaconda refinery is almost large enough to treat all the converter copper produced at the Anaconda works, —*i. e.*, nearly 170 tons daily,—contracts have recently been renewed with the Baltimore Works whereby they will continue to refine one-half of the total Anaconda converter copper output, undoubtedly because refining costs less at Baltimore, where wages are only half as high as at Anaconda, and because of the proximity of Baltimore to the chief market.

BOILER ROOM, LOWER WORKS.

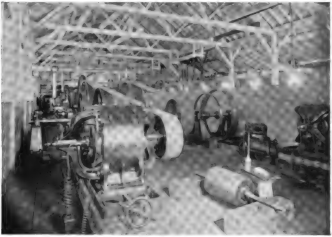
The two sections of the Anaconda electrolytic works are separated by a distance of one hundred feet, for security in case of fire. The buildings, framed in wood covered with corrugated iron, occupy a



THE PUMPING ENGINE, UPPER WORKS.

space of more than 14,000 square yards. The boiler house is two hundred feet, and the silver mill three hundred feet, from the refinery. A part of the following description of the power plant is taken from the *Engineering and Mining Journal.*

The new boiler house contains three sets of two Heine boilers each, having altogether an evaporating capacity of 62,200 pounds of water per hour. Another set of two boilers serves as a reserve. All the boilers are connected by a large iron flue, which takes the smoke and gases to a Green feed-water-heater, from which they are carried to a brick stack one hundred and forty feet high. The steam and feed-water line are common to all the boilers, and the connections are so made as to allow the cutting out of any one of the boilers.



THE DYNAMO ROOM.

Belt coal, containing 20 per cent. or less of ash, is successfully burned by underfed stokers of the American Stoker Company's make.

The ash is conveyed to an elevator by means of water in a sluice, and is finally dumped on the prairie adjoining the boiler-house. The supply of fuel is dumped from cars running in front of the boiler-house into large bins, and from there a bucket elevator dumps it into the supply-bins hanging in front of the boilers. From these bins the coal continuously sinks to the grate hoppers, and is then taken by the grates automatically.

The feed-water is handled by two large Knowles pumps, each alone of sufficient capacity to supply all the boilers. The water is taken

from the hot well of the condenser, and delivered by the pumps through the Green heater to the boilers, acquiring on its way a temperature of about 200° F.

The service of the boiler-house is performed by twelve men,—*i. e.*, two firemen, two helpers, and two fuel passers on each shift, under the supervision of the master mechanic and foreman of the refinery.

The power-house contains one 800 h. p. Corliss engine, one Westinghouse compound engine of 400 h. p., and two triple-expansion engines of 900 h. p. each, making a total of 3,000 h. p. The Corliss engine consumes 30 pounds of water per h. p., and the triple-expansion engines only 15 pounds.

THE MACHINE SHOP.

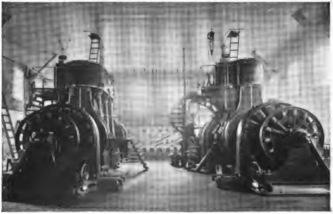
The electric current for the electrolytic work is supplied by seven Westinghouse generators, two being of 220 k. w. capacity and belt-driven, and five being of 270 k. w. capacity, four of which are directly connected to the triple-expansion engines. This gives a total current of 1,790 k. w., corresponding to 2,560 h. p. One generator and engine serves as a reserve unit, and can be switched over to any of the six circuits, in case of an accident or during repairs to any of the six other generators. There are also two dynamos for light and power, consuming together 50 h. p., and a 30-h. p. air compressor, which runs the acid pumps and the condensers for the engines, and consumes 1,500 pounds of steam per hour, equivalent to 50 h. p. Including 1,500 pounds for heating, 51,060 pounds of water evaporated in the

THE COAL HOUSE, FROM ABOVE THE WORKS.

boilers are required to run the above machinery, as against 62,200 pounds,—the maximum capacity of the boiler plant. This amount of power corresponds to a maximum production of 150 tons of electrolytic copper per 24 hours, or to about 17 h. p. daily per ton produced.

The above embraces the power required to manufacture cathodes, to handle and transport the copper, which is done by electric appliances, and to operate the silver mill. As labor here is more expensive than power, work is done by machinery whenever possible.

Each of two refinery tank houses occupies 6,500 square yards, and contains 600 tanks. The arrangement of the latter, as well as the usual method of refining, has been so frequently described elsewhere



ENGINE ROOM, DYNAMO, AND RESERVES FOR ELECTROLYTIC REFINERY.

that we do not treat these subjects in this article. We call attention, however, to an ingenious automatic register, employed in the Anaconda refinery, for controlling the refining operation. Every series of five tanks in the refinery is connected to this automatic, commutator-like register. A yoke carrying two brushes slides over its different segments, making one complete turn in an hour, and these brushes bring into contact the terminals of each series of five tanks to indicate the volts on a registering volt-meter. In this way all the tanks are controlled once an hour, and the readings registered on paper automatically. This enables the man in charge to see at a glance the condition of all the tanks in the refinery. He can see at once when any trouble occurs in a tank, and its nature; when it started, and how it developed. He is able to point out to the foreman the tank in question, and this instrument continues to record the time when the man started to correct the trouble, how much time it took him to do it, and also how completely the work was done.

The plates of pure copper, electro-deposited, are sent to the reverberatory plant to be cast into wire-bars. The plates are put into large reverberatory furnaces in the evening, and heated all night, finally to a temperature of 1,800 to 2,000° F. Charcoal is then added to the metal bath, and the little slag appearing is skimmed off. The last

EXTENSION OF ELECTROLYTIC REFINERY.

INTERIOR OF ELEVATOR TANK-HOUSE, UPPER WORKS.

traces of antimony and other impurities in the copper are then removed by "poling,"—*i. e.*, thoroughly stirring up the metal with long birch stems,—after which the copper is poured into suitable wire-bar molds. The bars, which are generally 42 inches by 4 by 4⅜, are sent to wire and rolling mills, to be drawn into copper wire.

The precious metals separated from the copper by the above electrolytic process are refined in the silver mill, and parted by sulphuric acid. Bars of fine gold and ingots of fine silver, which are mostly shipped to England, are thus secured.

In conclusion, we add a few data showing the magnitude of the Anaconda and other mines of Butte City. The total number of men employed at the mines and smelters of the Butte district exceeds 5,000, not including those working in the smelters of the Anaconda Company and of the Boston and Montana Company, comprising at least 2,000 more. The daily output of ore is about 6,000 tons. For the year 1896 the approximate value of the product was $35,000,000, and the profits were more than $6,000,000, divided approximately as follows: Anaconda, $3,000,000; Boston & Montana, $2,000,000; Montana Ore Purchasing Co., Parrot, Colorado, and Clark's properties, more than $1,000,000. In 1894 the Anaconda produced copper to the value of $11,000,000, and made a profit of more than $3,000,000. In 1896 its copper output was 125,000,000 pounds, besides 5,500,000 ounces of silver, and 17,000 ounces of gold. An interest

FIRE COMPANY AT THE UPPER WORKS.

in this property was recently purchased by the Rothschilds, it is known, for $15,000,000, and gold was shipped in payment.

Briefly, the striking features of the management and of the situation which have developed the property to its present enormous proportions are, on the one hand, the ownership of sources of the supplies which the company requires, such as timber, coal, and water, and the control of the railroad lines used (to avoid paying heavy freight charges), as well as the progressive policy shown in the adoption of the latest improved methods of treatment, and, on the other hand, the position of the reduction works, which are so placed relatively to the mines, although situated twenty-seven miles therefrom, as to avoid rehandling of material, coal, and ores.

THE CAUSES AND PREVENTION OF WATER FERMENTATION.

By Samuel McElroy.

RAPID progress in biological science, coming, as it does, to the aid of chemical science, and, in such cases as water analysis, furnishing what hydraulic engineers have long felt to be a needed supplement, within twenty years has changed the theories and practice of our medical authorities, and is rapidly leading, in agriculture and otherwise, to radical changes important to public welfare.

The fermentation of water is a subject which grows in importance with the rapidly-growing demand for, and distribution of, water in the various centers of population. The careful student who has collated the experience of the more populated centers on this point finds that fermentation is an active and universal law of depuration in reservoirs and other bodies of water, and demands a systematic attention which it has not, as yet, received in water-supply design.

Contamination, year after year, both in summer and winter, of the most prominent supplies has shown, at times, to any careful observer, the effects of the process by which nature depurates contaminated water. These effects have differed in period and intensity, but their occurrence has been common.

Actuated by local pride, when troubles come which should have been anticipated and prevented, city authorities have, in various times and ways, glossed over, tried to explain away, or ignored these evidences of contamination ; and quite a number of those who ought to know better—chemists, biologists, engineers, commissioners—have insisted that the trouble was only temporary, its causes more or less mysterious, its effects more or less mythical, and its sanitary effects harmless. The good name of the supply is to be guarded, and the suffering consumers are cautioned against any public clamor.

The general panacea of these wise men is flushing the mains at the street hydrants,—an operation performed at night, to save critical eyes from a shock. This shows what deposits the mains collect under their usual slow motion, and discharge under rapid currents ; and it usually aggravates the trouble, since the oxids of constant pipe-disintegration are, in themselves, valuable correctives, and, if the reservoir is contaminated by what it accumulates in its depths, the renewed supply more surely shows it, under the erroneous practice which neglects surface flow into the mains.

To the hydraulic engineer who has made this process a study, and is familiar with the theories and remedies of ancient practice, the causes and effects are plain, and the remedies equally so. Unfortunately, however, in the engineering profession struggling through a transition stage, studied experience has no adequate market value, and centers of population gain lessons by a prolonged suffering which is strangely universal.

Two great natural laws come into action here. From its abrasive weight, its absorbing power, its active solutions, and its incessant motion, water as rain, as flowing veins and currents, as expanding ice, or when distilled by evaporation, becomes rapidly contaminated in its descent through the atmosphere and its flow over, or through, the earth. It rapidly takes up, or becomes impregnated with, vegetable and animal matter, diseased or dead, and mineral salts.

Then, in the wonderful provision made for man's comfort and health, come into action the sanitary forces whose office is to depurate this organic pollution. Sunlight, as heat and otherwise, has one function; oxygen in aeration and motion has another; and the teeming sanitary police of the lower organic world, the algoid and fungoid ministry, with that of the protozoic forms, come in to fulfil their important share of the work. These forces—heat, air, and microbes—are the remedial trinity of diseased water.

The cause, then, plainly, is contamination by diseased or dead organic matter; and, since fermentation is, generally, nature's corrective remedy, the process here is putrefactive fermentation; and the odors and flavors observed are the usual evidences of this process, which must continue until depuration is accomplished. No scientific student considers heat, or oxidation, or microbes a direct cause of this phenomenon. He knows perfectly well that each is simply remedial for a distinct organic cause.

Let us now apply these premises to the supply-condition of the fourth city of the United States. Brooklyn, in 1895, is reported to have used 80,124,432 gallons of water per day, or more than 100 gallons per capita, for the twenty-five wards supplied by the city works.

The city works department, from amounts raised by tax and assessment, expended in 1895, $5,827,482, of which $761,717 was for water maintenance, including the respectable sum of $393,275 for salaries alone.

In addition, the house-holders paid $1,863,678 as water rates,—a total of $2,625,495 for the luxury of water-supply.

Brooklyn inaugurated in 1856 a supply of the highest rank in quantity, quality, and availability. The engineering theory of this plan may be thus stated:

Long Island, in the main, is composed of a porous mass of sand and gravel, sloping up from the ocean on one side and the sound on the other to a central ridge, which rises several hundred feet above tide, and contains occasional deposits of clay, bowlders, etc. The rain falling on this surface is readily absorbed, and passes down to a saturated bed, as through an enormous filter, which rises landward from tide-level, with an hydraulic frictional slope, generally of eight or ten feet per mile, except near tide. On the Hempstead plains, at a distance of 9.38 miles from tide, and a ground elevation of about 210 feet, the water stands 78 feet above,—a mean slope of 8.34 feet per mile, and a direct filtration, to reach it, of 132 feet.

Along this southern slope, easterly from New York bay, depressions occur at frequent intervals in this formation, near tide, generally as swamp beds from which powerful springs issue, forming creeks, each flowing to tide through its own valley; and there is considerable appropriation of these as mill-ponds, near tide.

Under the plan of 1856, an intercepting aqueduct was built, from the Ridgewood Pump well to Hempstead Reservoir, 12.39 miles, completely controlling a basin of 88.64 square miles. Of about eighteen creeks which it crossed, five of the more prominent were selected, their mill-ponds being formed into supply reservoirs, and a sixth was excavated on Clear stream. Abundant experience has shown their flow,—about 36,000,000 gallons per day; the rest, on a catchment of not less than 1,200,000 gallons per square mile, or 106,000,000 per day, wasting at tide unless intercepted.

In 1875, under the Kingsley *régime*, Brooklyn expended about $1,500,000 for the Hempstead storage reservoir, endorsed as capable of furnishing 100 days' summer supply of 10,000,000, in addition to the creek flow of about 8,000,000. It has a maximum capacity of 850,000,000, at a depth of 29 feet, which it has never been able to realize, and its capacity at any level suppresses the natural stream flow in proportion.

In 1892 an extension aqueduct was built, to Massapequa, a point 22 miles from the pump well, which intercepts a basin of 88.5 square miles. On this five supply reservoirs were built, credited with a gravity flow of 31,700,000, in 1895, from a total daily basin flow of about 106,000,000. The streams which feed these eleven reservoirs vary in length from 1.3 miles (Newbridge) to 4.5 (East Meadow), on the Extension, and 2.5 (Jamaica) to 3.25 (Hempstead) on the original line. They outcrop in depressed basins, in which masses of swamp growth have accumulated; various similar pond depressions occur in their descent, and the lower ponds have swamp inlets.

Jamaica valley, for a mile above the reservoir, has a broad swamp

area, about a quarter of a mile wide. In building the embankment of the South Side Railroad across it, the writer had the swamp peat excavated, in some cases to a depth of more than four feet, to get a firm slope rest.

On the extension the city acquired for aqueduct right of way and pond construction 484 acres, with 810 acres of head swamp lands, leaving about 802 similar acres on the five streams yet to be purchased; and the actual area of pond excavation, for a minimum depth of 2½ feet, appears to have been about 69 acres.

The new storage reservoir of 1875 was incomplete, when abandoned, 47 acres in the valley remaining entirely uncleared of rank vegetation. Kept, as it necessarily is, at about half-depth, rank vegetation grows at the head, to add to its supply contamination.

On the extension, then, the water, however pure when it crops out in bed-springs, is in direct steepage contact with about 1,540 acres (nearly 2½ square miles) of vegetable contamination; and on the main line no adequate effort has been made to remedy a similar exposure—for a swamp depth of 4 feet, in some cases.

In the winter, when a sleet storm comes on the frozen ground, a large surface wash into the reservoirs occurs, carrying its quota of organic matter from a highly-cultivated district and producing strong discoloration in the city mains.

As early as 1872 a supplemental supply by detached wells was commenced, below the aqueduct. This has been rapidly extended, so that, on the main line, eight stations are now in use, while, on the extension, the same method is being largely applied. Excepting two cases of "sunken wells," these are "driven tubes," using each about 100 2-inch tubes driven to great depths—45 to 90 feet or more.

Experience shows that instead of securing, as was expected, filtered water of great purity, none approaches the purity of the gravity outcrop,—about 3 grains of solid matter per gallon. The sunken well at Smith's pond, fed from it, in November, 1890, gave 3.66 grains (100,000 parts); Forest Stream, 5.84; Clear Stream, 6.04; Baiseley's, 10.28; Spring Creek, 17.96.

There are two, sometimes three, explanations. First, that, the passage along the tube downward to the suction-point being vertical, with less descent friction, and also cleared from the fine sand in interspaces, the tubes draw surface water, rather than that of the lower, horizontal beds; and this is swamp- or surface-contaminated. A property-owner and long resident on the extension says:

"I know every pump or well driven by the contractors between Freeport and Wantagh, and pumping now; nearly all of them are in swamps. . . . The pumping station at Clear Stream is shut down.

The whole pond is but little more than a morass, being overgrown with water-grass and weeds."

Of the actively-pumped and costly Spring creek well, E. H. Bartley, chemist, says in the board of health report of 1885:

"The wells (tubes) are located on low ground, near a former stream and swamp, both of which are now drained entirely dry. The distance from the Jewish cemetery is 370 yards. The land about the station is under cultivation, by frequent applications of stable manure. . . . The influence upon (neighboring) wells and subsoil water extends much farther than the distance to the cemetery. It is, in my opinion, demonstrable that the subsoil drainage from the cemetery and filthy barnyards in the neighborhood finds its way into these wells, and thence to the general water-supply of the city."

This is accompanied by an analysis, giving solid contents (100,000) of 33.4 grains and ignition loss (organic) of 12.28.

A second source of accumulated matter is found in the motionless condition of these deep beds, and their constant reception of whatever impurities reach the surface of the saturated bed, and continue to descend without being carried off. It is well known that nitrifying organisms rapidly diminish in number with increased filter-bed depth, and at these great depths they cannot act.

A third danger, and at least occasional contamination, comes from the objectionable proximity of these deep tubes to tide-line, some being not 500 feet distant, and 45 to 90 feet below tide-level. Whenever, then, the tidal pressure exceeds the landward slope pressure, in a case where these wells at work lower the saturated level 3 to 10 feet, salt water will begin to saturate the intervening bed, and, as time goes on, the supply will become more and more brackish, and must be abandoned.

To all these contingent risks and facts of contamination must be added the increase of population, agriculture, manufacture, and the like, on the feeding area of this saturated bed, and along the flowing creeks in use. Sewage, farm manure, and factory pollution must be expected, and must be provided for wisely and effectively.

The original contract and specifications for these works were drawn by the designing engineer, and the works were constructed substantially in accordance therewith. They contained three special provisions against fermentation, in a case where less than 10,000,000 per day could be used, and where the 20,000,000 provided for would not be required for fourteen years.

Under the first provision, as to the ponds below the flow lines, all vegetable and perishable matter must be cleared.

The second made the westerly supply reservoir, Jamaica, a depu-

rating reservoir for the entire supply, from which, by careful subsidence and surface-decantation, the purified flow could enter the aqueduct.

The third formed the Ridgewood distributing reservoir in three apartments, from which, by the same process of subsidence and three-fold surface-decantation, through connecting wells, the purest water could enter the mains.

For the extension, then anticipated, and, in fact, provided for by the purchase of important ponds, Smith's pond was provided for a similar depurating reservoir.

In the actual construction of the original work, and on the extension, not one of these four safeguards has been properly secured ;—the last three not at all. In fact, the fundamental plan of the works has been so far ignored that, when, even in 1895, the lower main aqueduct, capable of eventually carrying 100,000,000, was used for a flow of 43,800,000, the remainder was passed, at very great pumping expense, through a 48-inch main, from Millburn engine-house, though the main cost, at the outset, about $1,100,000, with a probable life of not much more than thirty years. A second more valuable 66-inch steel pipe is now under contract at nearly $1,000,000 more.

Under public clamor, and a hurried common council appropriation, steps were taken to clean out one of the ponds. As an additional safeguard a laboratory for analyses has been established at Rockville Center, to eventually determine the cause of the putrefactive fermentation.

Much credit is claimed by the department for three years' expenditure in cleaning ponds, and is due for what has been done ; but there is still, on a large scale, constant exposure to local contamination, which is the source of the present trouble.

Health Commissioner Emery ascribes the bad odor and color to the "presence of living and decomposing vegetable matter in the ponds, reservoirs, and distribution system." This opinion is concurred in by Drs. Bartley, Hutchinson, and others, from personal inspection of a "large collection of decaying vegetable matter" in the ponds.

These conclusions, in the opinion of the engineer-in charge, furnish "a partial, though still imperfect, designation of the origin of the trouble, but its specific cause remains undefined." His remedy is "the continued observation, examination, and analysis of all our sources of water, so that we may become thoroughly familiar with their characteristics, and the most efficient treatment in any given case." This is further defined as, "not only chemical analysis, but color tests and biological examination, embracing that of the microscopic organisms, and that of the bacteria, as well as their complete differentiation in each case, as far as practicable ; . . . .

experiments made to ascertain the mode of operation of the cause of the trouble, and corrective treatment to be applied."

The only consistent and proper remedy, then, for a dead horse on the street is a series of laboratory analyses to ascertain, as far as practicable, a suitable remedy !

The theory of the original plan was simple, effective, and economical. From a level near mean high tide, as we have seen, the vast saturated sand and gravel bed of the southern slope of the island rises towards the central ridge on an hydraulic slope of about eight and a half feet per mile. The upper roof of this slope, along the line now controlled by the Brooklyn aqueduct, daily discharges towards tide about 205,000,000 gallons of the purest filtered water, under the surface.

Could a more simple problem in hydraulic engineering be presented than the effective interception of such a flow, on such a slope, not where it crops out to be contaminated, but where it flows, clear and clean? It would make an engineer of ancient Rome turn in his grave to be told that for thirty years Brooklyn has been stumbling over this problem ; that, after acquiring, at the outset, 36,000,000, with an outlay of $5,400,000, she has since expended for extensions and interest about $33,000,000, including at least $1,750,000 for wells; and that her officials have been contemplating an additional outlay of $25,000,000, to meet the demands of 1900, wandering into northern New Jersey to face a sectional State contest, when all this water, in all its purity, is running to waste, day after day, under its present aqueduct !

Nor is there much comfort promised in the eventual remedy of "sand filtration" discussed. The ancient engineers, by careful aeration and subsidence, oxidized and depurated the organic matter, and thereby, in a simple and natural way, greatly reduced the normal quantity of microbes by clarifying and removing their food-supply. But, in the expensive *single-process* sand filters of the day, so extravagantly lauded, through a bed of two and a half to four feet, all the organic matter, flood laden or otherwise, is accumulated, and with it a necessary accumulation of microbe organic slime, which pervades the entire bed, and through which every gallon the consumers drink is forced under hydraulic pressure !

For 100,000,000 per day, for Brooklyn, the estimated cost of installation plant is about $1,700,000, with uncovered beds, and $2,700,000, with covered beds; with the comfortable operating outlay of $1,200 per day, uncovered, and $1,600, covered; $438,000 per year in one case, and $584,000 in the other,—a sanitary and financial conclusion for tax-payers to study.

THE PATENT SYSTEM AS A FACTOR IN NATIONAL DEVELOPMENT.

By William C. Dodge.

THE question is sometimes asked: Is a patent system of benefit to a country? and not infrequently we find men and papers advocating the abolition of patents. Those who entertain such ideas generally belong to one of two classes,—persons who confound modern patents with the "odious monopolies" of former times, and who think that inventions would be secured just as well without patents, and those who think that labor-saving machines deprive men of employment, and are therefore injurious to the laboring classes.

This opposition has exhibited itself from the beginning down even to the present day. It is but a few years since a writer in a paper published at the capital of the United States asserted that "the invention of the steam engine and the sewing-machine were among the greatest evils that ever befell mankind"; and it is a matter of history that in the same enlightened land prayers were offered in some of the churches that the wickedness of the newly-invented sewing-machine might be made apparent, and its makers be struck with a conviction that would induce them to stop its manufacture!

More recently an organ of a labor organization insisted that the introduction of patented machinery worked injury to skilled labor, as have also the leaders of some of these organizations, and writers in periodicals, during the past year.

It is to correct these erroneous impressions that I present the following facts.

If those who confound modern patents with the "odious monopolies" granted by the monarchs would but consider for a moment, they would see how erroneous such an idea is.

Under the old system of "monopolies," rights of which the public were already in full possession were arbitrarily taken from the public and conferred upon individuals, greatly to the injury of the public. For instance, Queen Elizabeth bestowed upon her favorites the exclusive right to sell steel, salt, and other articles in the kingdom, the price of salt by the monopoly being increased from sixteen pence to fifteen shillings,—over eleven hundred per cent.!

On the contrary, a patent, instead of taking from the public anything which it already has, induces the inventor to spend his time,

labor, and money, and exercise his genius, in devising and giving to the public something new,—something which it wants, and which, but for his invention, it might never have had. True, it gives him the exclusive right to make, sell, or use the invention, but only for a brief period, and that only upon the condition that he shall so illustrate and describe it that the public can make and use it at the expiration of his limited right, and thereafter have it free forever.

The difference between a modern patent and an old-time monopoly is as clear and as distinct as the difference between day and night, and there is no excuse for their being confounded by any intelligent person. In fact, it was to abolish and prohibit the "odious monopolies" that the patent system was established.

In no part of the world have inventions been so extensively made and used as in the United States, and there can be no better way of determining whether the patent system has been beneficial, and whether or not it is for the public good to continue it, than to consider what it has done for that country.

To get an idea of what has been accomplished during the first century of American existence under the patent system, let us briefly compare the condition of the United States in 1790 with that of 1896.

Their territorial area has increased from 830,000 square miles to 3,314,220; their population from 4,000,000 to more than 70,000,000; their 75 post-offices to about 70,000; and their 1,500 miles of postal routes to nearly 500,000 miles, on which there is a travel of 409,388,425 miles,—enough to encircle the globe more than 16,000 times! In 1790 they had practically no manufactures. At the close of the revolution their manufactures amounted to only $20,000,000, the total product as late as 1830 being but $80,000,000; while in 1890 their manufactured products amount to almost $9,250,000,000—far more than those of Great Britain, and more than one-third of the total manufactured products of the world! At the same time their agricultural products have grown to the sum of $4,500,000,000 per annum.

In 1790 such things as steamboats, railroads, telegraphs, and telephones were unknown, while now the United States have 181,000 miles of railroad with a total trackage of 221,000 miles, giving employment to about 800,000 persons.

The street and suburban railways aggregate nearly 40,000 miles, of which nearly one-third are electric roads, with 30,000 motor cars.

On the 15,000 miles of western navigable rivers, and 95,000 square miles of lake surface, there are 2,705 steamers, with a tonnage of 806,584 tons, while the craft on these inland waters number 10,237 with a tonnage of 4,319,734 tons. The traffic on the great

lakes alone amounts to nearly 40,000,000 tons. During the eight months of navigation 60,000 vessels pass through the Detroit river, with a tonnage of over 36,000,000 tons. The tonnage of entrance and clearance of the two ports of Chicago and Buffalo exceeds that of any city in the world, except London, and very nearly equals that (London, 20,962,534; Chicago, 10,288,868; Buffalo, 9,560,590). From the single port of Escanaba, on Lake Michigan,—a place so young as to be unknown abroad, and known to but few at home,—there were shipped in 1892 nearly 4,000,000 tons of iron ore, and 120,000,000 feet of lumber,—her tonnage being more than half of that of Liverpool, which is excelled only by that of London.

The United States produce now more iron ore, and manufacture more iron and steel, than Great Britain, which heretofore has led the world in that line. They have 839,905 miles of telegraph wires, with 25,000 stations, independent of ocean cables, and 440,750 miles of telephone wires, with more than 500,000 instruments in use.

But, wonderful as these statistics show the growth of the country to have been, they do not tell the whole story; for it must be borne in mind that in 1790 the four millions of people were scattered mostly along the Atlantic seaboard in sparse settlements. Moreover, it must be remembered that this small number of settlers had the whole continent to subdue,—forests to clear, farms to open, houses, roads, bridges, schools, and churches to build, in fact, everything to create, with the savages to contest every foot of advance,—and that the western continent had neither the accumulated wealth or the surplus labor of the old world with which to accomplish this gigantic task. But even that is not all, for, in order to get a clear idea of the conditions under which the United States began existence as a nation, one must consider also the restrictions placed upon the colonists by the mother country.

The policy of the mother country from the very first was one of suppression of all manufacturing industries. As early as 1621 an order of the king and council prohibited the shipment of tobacco or any other production of the colonies to any foreign port, except to be first landed in England, and a duty paid on it there.

This policy was continued even after American independence, and various acts, from 1781 to 1796, were passed, prohibiting under heavy penalties the shipment from Great Britain of "any machine, tool, engine, press, paper, utensil, or any part thereof, or any model or plan thereof, which was, or thereafter might be, used in the manufacture of woolen, cotton, linen, or silk manufactures," and also prohibiting the shipment or enticing away of any artificer or workman in these several branches; and in 1795 this act was made perpetual.

It was not until 1825 that the restriction upon workmen leaving the country was repealed, and that upon machinery not until 1845.

The object of all this, as stated in the preamble to the act of 1763, was "the keeping of his majesty's subjects in the colonies in a firmer dependence," "the increase of English shipping," and "the vent of English manufactures." The idea and purpose of the British government in reference to the colonies was succinctly stated by Sir Robert Peel, when he said: "It is the destiny of the United States to feed Great Britain, and the destiny of Great Britain to clothe the United States."

Of course, under such control by the mother country, the colonists could engage in nothing but farming and the production of raw material, to be shipped to England for the use of her manufacturers.

During the revolution, manufactures were established to partly supply home needs, but with the close of the war a reaction set in that soon destroyed most of them. Under the confederation of the colonies, which was solely for common defence, the general government had no power to grant patents, or to regulate commerce, or to impose duties on foreign goods, those rights being exercised by each colony or State as it saw fit. Massachusetts, New York, and those most interested in commerce, imposed no duties, and the result was that, in a year or two after the close of the revolution, the country was so flooded with the cheap products of England and other countries as to break down all the manufactures that had been established during the revolution and bankrupt the merchants. So terrible was the condition of affairs that petitions were sent to congress asking it to issue "fiat" paper money, and loan it to the people. In Pennsylvania the State government actually did this.

It was this condition of affairs which finally resulted in the constitutional convention in 1787, which conferred on congress the powers under which the country has since grown to its present estate. Among the powers conferred on congress by the constitution, two of the most important, so far as national prosperity and growth are concerned, are the power to regulate commerce and impose duties on imports, and the power to provide for the grant of patents. These may well be termed the right and left arms of American growth and prosperity, and it is a question which, after all, is the right arm, and which the left. Under the exercise of those two powers, for the first century of existence, the United States have so grown and prospered that they now do one-third of the world's manufacturing, one-third of its mining, and one-fifth of its farming, and possess one-fifth of its wealth. And, best of all, this is the result of peace, and the intelligent application of the arts.

Now, what has caused this marvellous growth? Doubtless there are several causes. The cheapness of a virgin soil and free institutions inducing immigration from abroad were two of the causes; but those alone do not account for it.

By some it is contended that the tariff has been the prime cause of American prosperity. Without desiring to discuss that or any political question, and admitting that a tariff is necessary for national revenue, and that it has been, and is, of importance to the manufacturing interests of the country, I assert, without fear of successful contradiction, that the patent system of the United States has been, and is now more than ever, one of the prime causes of national growth and prosperity.

As stated by Commissioner Leggett in his report for 1878, from three fourths to nine-tenths of all American manufacturing is based, directly or indirectly, on patents; that is to say, the people are engaged in manufacturing patented articles, or are using patented machines and processes to manufacture articles not patented.

One need but step into any shop where articles are being produced—from the saw mill in the woods that now cuts its 300,000 feet per day, to the little shop in the attic where toys are produced, or the great factories turning out their millions' worth of articles of every variety—to prove the truth of this statement. In fact, you cannot touch a thing anywhere, in the shop, on the farm, in the household, or the office, that does not bear the impress of patented inventions.

But to show that this is not merely an individual opinion, let me quote what an intelligent Englishman says on the subject. Harris Gastrell, secretary of the British Legation, in a detailed report a few years since to his government upon the industries of the United States, says:

I cannot close this report without recording the fact that, in every important branch of industry referred to in the course of the previous pages, the American manufacturers seemed to be ever gaining on their competitors of the old world *by availing themselves to the utmost of every advantage of improved process or labor-saving machinery* which American or other inventors may offer.

There can be little doubt but *the celerity with which all such advantages are thought out and then introduced into general use* is owing to the constant pressure of high rates of wages, and *the comparative certain protection of capital invested in inventions.*

Neither can I close without observing how favorably the great industries of the United States would probably compare with the best organized of the competing industries of Europe. The past history and present development of the textile (and metal) industries is an earnest of a prolific future. Whether or not a reduced cost of living shall ever be attained, I cannot doubt that, under sound conditions of production, American industry will *not only supply its own market, but will also become a formidable competitor in foreign markets* in many articles.

How soon that competition abroad may take place in this or that industry is not

for me to conjecture. But I think that the data in this report are sufficiently full and correct to enable others to predict that time in respect to the cotton and woolen industries.

At a meeting of the British Association, after his return from the Philadelphia Centennial Fair, Sir William Thompson said:

I was much struck with the prevalence of patented inventions at the exhibition; it seemed to me that every good thing deserving a patent was patented. I asked one inventor of a very good invention: "Why don't you patent it in England?" He answered: "The conditions are too onerous." We are certainly far behind America's wisdom in this respect. If Europe does not amend its patent laws, America will speedily become the nursery of inventions for the world.

Mr. Hulse, the English judge of textiles, in his report to parliament, said:

The extraordinary extent of ingenuity and invention existing in the United States and manifested throughout the Exposition I attribute to the natural aptitude of the people, *fostered and stimulated by an admirable patent law system.*

So, too, the Swiss commission were so impressed by what they saw at Philadelphia that they published an address to their manufacturers, in which they told them that their only hope was in the adoption of a patent system; and the result was that Switzerland in 1888 adopted a patent law.

The United States consuls, in their reports to the State department on the effect in Europe of the Centennial Exhibition in 1876, show how American implements and products were being preferred in Europe, especially agricultural machines and tools; and Consul Winser gives long extracts from a book published by Dr. Herman Grothe, a prominent German political economist, who visited the fair for the sole purpose of "studying the principles which had operated so powerfully in bringing about this rapid and high development of American industries," and who lays great stress on "the *stimulating effect of the patent laws.*"

Dr. Grothe further says:

Moreover, owing to the use of labor-saving machinery and finer and better-adapted tools, the cost of manufacture, in spite of higher wages in the United States, is lessened to the point where competition with other nations in supplying foreign markets may fairly be tried; and there can be no doubt that a great many lines of American wares will eventually find ready sale in the German market, in some cases to the exclusion of the same classes of goods of English, French, and even home manufacture. All this is granted.

In the reports of the British commissioners to parliament it was stated that, "as regards extent of invention and ingenuity, the United States was far ahead of other nations"; that "a great part of the marked advance in the improvement of workmen's tools which has been made during recent years is justly due to the inventive genius of American citizens"; that "one cannot fail to notice the great

fertility of invention displayed in America"; that "there is great inventive power, and a ready and fearless adaptation of the means to the end sought"; that "no one could fail to be struck with the great and successful application of science to useful purposes in America"; and that, "judged by its results in benefiting the public, both by stimulating inventors and by giving a perseveringly practical turn to their labors, the American patent law must be admitted to be the most successful, and the beneficence of its working was very amply illustrated throughout the American region of the Exhibition."

Edward Bally, one of the Swiss commissioners, said:

> I am satisfied from my knowledge that no people have made, in so short a time, so many useful inventions as the Americans; and, if to-day machinery apparently does all the work, it nevertheless by no means reduces the workman to a machine. He uses a machine, it is true, but he is always thinking about some improvement to introduce into it, and often his thoughts lead to fine inventions or useful improvements.

As a result of these obvious facts, a committee of the British parliament some years ago, after two years of investigation, recommended the adoption of the American patent system, and again in 1894 the subject was agitated. Norway and Sweden in 1885, Canada in 1886, and Germany in 1888 adopted a similar system of preliminary examination, and now they grant patents only for what is new and original. Thus the foremost manufacturing nations of Europe recognize the superiority of the American patent system, and make acknowledgment of its beneficial results.

Now, when the United States manufacture more than they consume and seek other markets for a surplus of both manufactured and agricultural products, the patent system more than ever becomes important; for, with higher-priced labor and raw material, how are goods to be made there, and sold in Central and South America, in open competition with the cheaper labor and cheaper raw material of England, France, Belgium, and Germany? If the cost of both labor and material could be reduced to a European basis, then, of course, America could compete; but that cannot be done, for the price of labor cannot be fixed by law, nor would the United States want to reduce it, if it could. That was tried in England and also in New England, and abandoned centuries ago.

The main hope is in inventions, and the skill and energy of the American people. If inventors can furnish manufacturers with improved machines and processes, which will reduce the cost of production from fifteen to twenty per cent., then the new world can compete with the old world; otherwise not. Already that point is rapidly approaching, as the following facts show:

In 1830 the manufactured products of the United States amounted to but				$80,848,210
By the census of	1850	they had grown to		1,019,109,616
" "	1860	" " "		1,885,861,676
" "	1870	" " "		3,385,860,354
" "	1880	" " "		5,369,579,191
" "	1890	" " "		9,224,541,094

or, according to Mulhall, more than one-third of the total manufactured products of the world!

This remarkable increase has been largely, if not mainly, due to inventions, stimulated and fostered by the patent system. As proof of this I cite the fact that the amount per hand employed has constantly increased. For instance, as shown by the census reports, in 1850 the product per hand, yearly, was $1,564, while in 1890 it had grown to $2,250,—an increase of nearly 44 per cent. in forty years. During that time the hours of labor have been reduced at least 20 per cent., and yet the product per hand has increased, as above shown. Nor is this all, for, while the hours have been decreased, and the product increased, the wages paid those hands have increased in even greater ratio, or from an average of $247 per year in 1850 to $450 in 1890, an increase which is even further augmented if measured by the purchasing power of a dollar then and now.

Now, how is it, and what is it, that enables an operative to-day to produce so much more, in a less number of hours, than he could thirty or forty years ago? It is simply *invention*, as embodied in the improved machines, tools, processes, and appliances that American inventors are constantly furnishing to American manufacturers.

Near Baltimore there was recently erected one of the largest plants for the manufacture of Bessemer steel in all its forms in the world; and, as recently stated by its superintendent, by means of the inventions and improved appliances they have adopted they are enabled to produce a ton of steel with but one-third of the manual labor required at their other establishment, built twenty or twenty-five years before.

In 1866 steel rails cost $165 per ton. In 1884 they had dropped to $34, in 1893 they were $21 to $24 per ton, and in 1897, even less. See how that has expedited the building of railroads, which now cover the country like a net-work, and without which modern existence could not be carried on. And the same is true of steel in all its forms, so that to-day we build steel bridges, steel vessels, steel cannon, steel frames for our buildings, and for farm implements, and use steel nails.

Inventions and improvements have so reduced the cost of steel rails that already, during the year 1897, the United States have sold 100,000 tons to Europe. They sold 100,000 tons of pig iron from

the southern states in 1896, and this year it is estimated that it will be 250,000 tons, where before the war none was produced. In 1896 the American export of iron and steel, manufactured and unmanufactured, amounted to over $41,000,000.

As an illustration of the benefits of invention, take the common nail. In 1818, when they began to be made by a machine operated by hand in Pennsylvania, they cost from 18 to 37½ cents per pound, according to size. Now they are sold at 1 to 1½ cents per pound,—so cheaply indeed, that a carpenter, working for 30 cents per hour, had better let a nail go than to spend ten seconds to pick it up, for ten seconds of his time is worth more than the nail!

In a report made by the United States consul at Birmingham, he cites a paper prepared by an English expert, who forcibly describes the danger from American competition to the British manufacturer of steel.

That is the result of invention. And the same is true of nearly all branches of manufactures. Says the *Iron Industry Gazette*:

"Disparagement of patents is common and easy, but it should not be forgotten by those who sneer at inventors that, out of a total of over $8,000,000,000 of capital invested in manufacturing in the United States, patents form the basis for the investment of about $6,000,000,000. Evidently, the United States system of encouraging invention that has resulted in the patenting of over 500,000 inventions is a system that is exceedingly wise and valuable. *The one thing that has enabled manufacturers to make so wonderful a progress in the United States is its patent system.*"

THE ARCHITECTURAL RELATIONS OF THE STEEL-SKELETON BUILDING.

By F. H. Kimball.

THE layout or arrangement of a large modern office-building, or of any building exceeding, say, eight or ten stories in height, is influenced to a great extent by the methods to be employed for upholding the structure. As the height or the number of stories is increased, walls of masonry alone soon become structurally impracticable by reason of the great thickness sure to be developed in the lower stories and the consequent loss of rentable area. The architect must therefore study, and in his design be influenced by, the best means in vogue for carrying the floors, together with the loads likely to be imposed thereon, as well as all the walls, both interior and exterior.

Our building laws, before the high-building period set in, were such as possibly to develop walls of three or four feet in thickness in the first story; but, whatever reduction of rentable space resulted, clients were apparently satisfied. In fact, they had no choice, as there was no appeal from the law in this respect. This state of things does not prevail in every city. In some of the large cities compilers of the building laws seem to have more faith in the adhesive and sustaining qualities of brick and stone masonry, but in New York city they are more conservative. It is a matter of conjecture whether the controlling motive was lack of confidence in the fidelity of our builders to use the best of everything, or a desire to emulate the example of those in olden time who "builded better than they knew,"—whose works were imperishable, standing to-day as monuments to the honesty and ability of those commissioned to build them. It is fair, however, to take a charitable view, and believe that our building laws are more perfect than those of other cities.

It is not to be regretted that the master minds which gave us all we have to-day, architecturally speaking, knew nothing of modern expedients in construction. It is scarcely possible to conceive what they would have done with a sixteen- or twenty-story building, while preserving the breadth and repose of the examples handed down to us. We do not know what exterior effect they would have produced where the walls were hung on a steel cage, with all the accompanying restrictions as to weight and thickness; how they would have preserved an apparent stability of pier and wall space, and secured at the same time well-lighted rooms for any kind of business; nor with what suc-

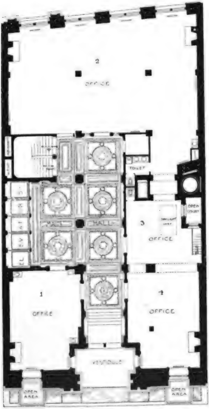
cess they would have met the many bugbears in the form of girders for the support of walls, and columns to carry them by which modern architects are oppressed. It is natural to suppose that the genius which created and developed architectural styles would no doubt have solved such problems with greater skill than that shown by the architects of to-day. Whether they would have clothed their tall buildings with masonry, or, recognizing the lightness and pliability of metal as an external skin, would have devised some preservative treatment whereby the life of the metal might be so prolonged as to make it commercially valuable, it is impossible to conjecture. When we study the great examples of masonry construction, one of the greatest and the first being the Duomo at Florence, followed by St. Peter's at Rome, it seems fair to presume that something would have been worked out with great boldness of design and construction.

Would they have considered the subject from the engineer's standpoint? That is, given a rigid steel frame composed of columns and girders supporting floors of steel beams filled in with masonry, braced to withstand any degree of wind-pressure without the need of other reinforcement than of metal, would they not have devised and attempted to preserve the same degree of lightness throughout by conceiving some covering of a similar nature to encase this frame? Or would they have used materials which have no affinity for metal, forming a covering of great weight, perishable, difficult to replace when injured or destroyed by fire or the elements, and, after all, suggestive of something which does not exist, for there is no evidence of the substance back of the covering? Not that we should make evident the structural supports in the design, but it is a common custom to "thin down" the piers and wall surfaces of a building, for the purpose of amply securing well-lighted rooms, at the expense of correct architectural composition.

While the beauty of stone and brick in color and texture is not to be questioned, conditions may arise which demand a radical departure from the traditions that dictate their use. In place of stone or brick, why not use iron or steel plates, or a composite plate, bolted or riveted to the steel frame? This could not be considered a return to the cast-iron imitation of stone masonry which prevailed twenty years ago. A more rational and natural use of metal might be devised which would not have the elements of a cast-iron front. Possibly the treatment of its exterior surface by a preservative coating would give it the desired color effect, and at the same time save frequent painting. At any rate, there may be a thought in this which some architects will eventually attempt to work out, and the effort may lead the way to something better.

THE MANHATTAN LIFE BUILDING, NEW YORK.

THE BOWLING GREEN BUILDING, NEW YORK.
By the courtesy of W. & G. Audsley, Architects.



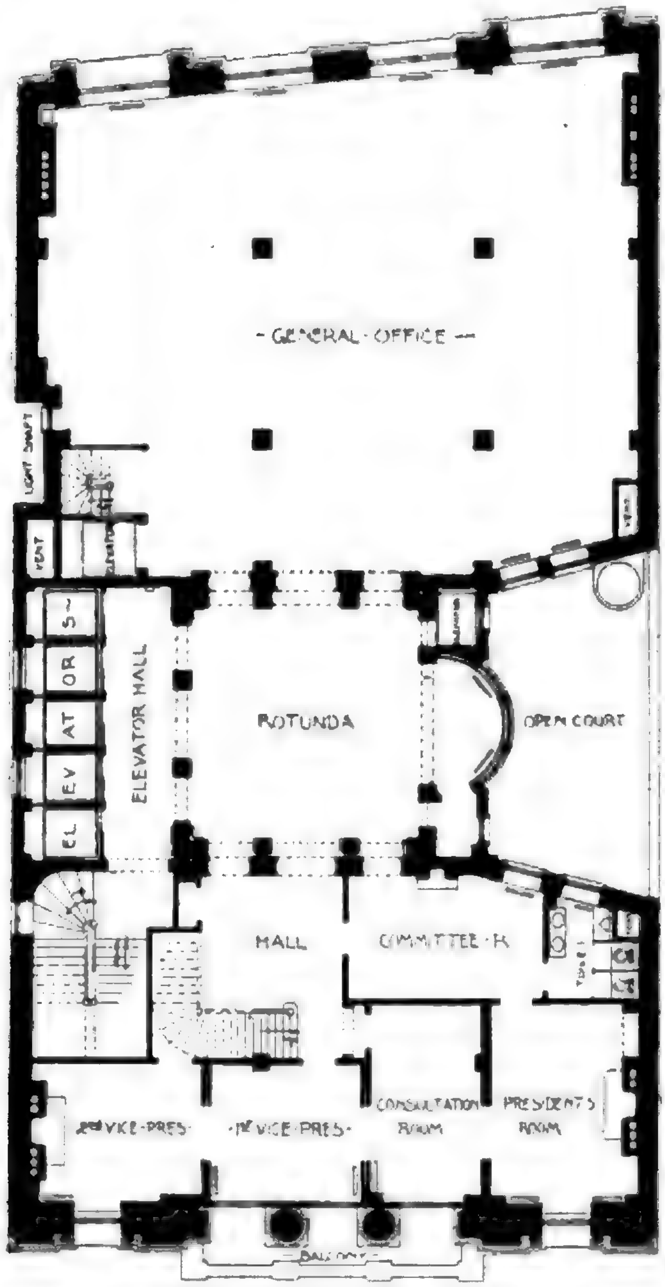
MANHATTAN LIFE BUILDING, NEW YORK
FIRST-FLOOR PLAN.

In the designing and laying out of a building in which the use of a steel frame is contemplated, the architect of to day has far more to think about and provide for than he had under the older systems of construction. The external design and interior arrangement, to a certain degree, must be worked up together. It is essential, however, that the arrangement shall conform to surrounding conditions, principally as to the available source of light, whether that source be the street, or courts, or both. Then must be considered the placing of the entrance to the building,—whether at one side, or directly in the center of the architectural composition,—and its relation to the elevators, which must be conveniently placed where they will best serve the interests of the tenants and public for quick access and at the same time occupy space of least value for rental purposes. These two features are most important in the design of a building. The elevators must also be considered in connection with the plan of the upper stories.

In determining the constructive features it is necessary to consider the location of the structural supports. A cut-and-dried spacing of the supports—that is, columns regularly arranged, just so many in the depth at an even number of feet and inches apart, and just so

THE COMMERCIAL CABLE BUILDING, NEW YORK.
By the courtesy of Harding & Gooch, Architects.

NATIONAL BANK OF COMMERCE BUILDING, NEW YORK.
By the courtesy of James B. Baker, Architect.



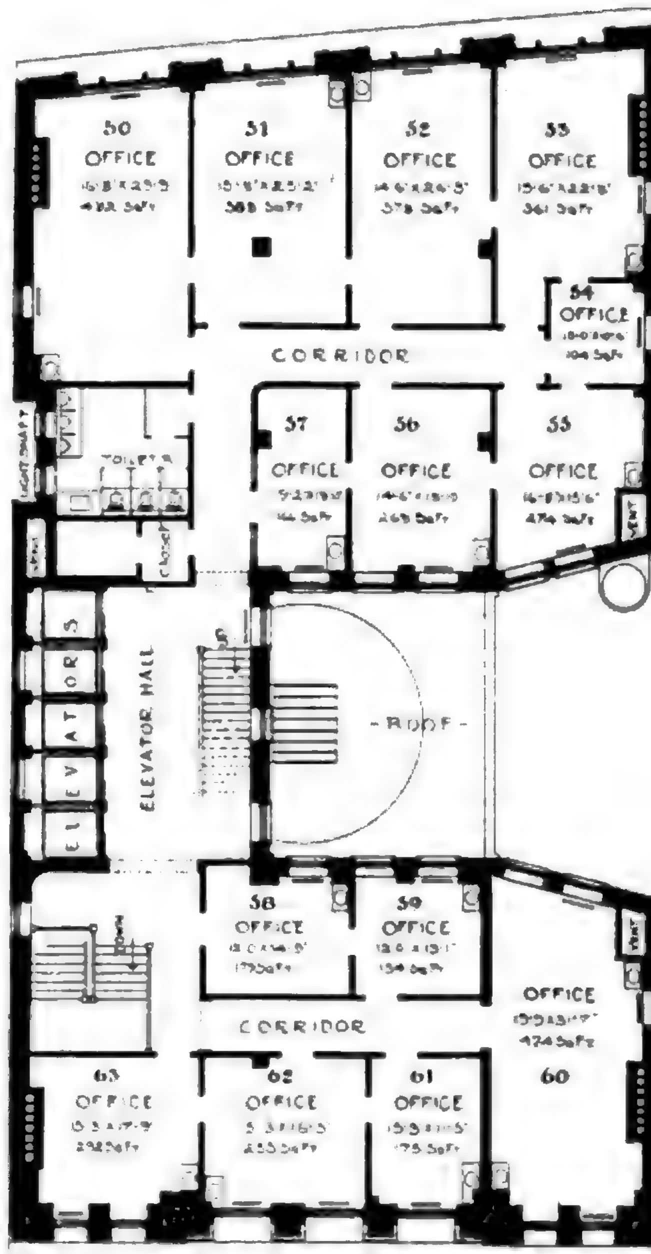
MANHATTAN LIFE BUILDING, NEW YORK.
SIXTH-FLOOR PLAN.

many at equi-distant spacing in the width—is in many instances impossible. It simplifies the engineering problem, but is sometimes incompatible with results which an architect strives to obtain in the treatment of halls or specially large rooms, such as corporations require. Again, a line of columns may come so near a division wall or partition as to make it desirable to put them out of sight; or there may be stories of a special character (similar to the sixth and seventh stories of the Manhattan Life Building, with which the writer is identified), where it is desirable to bury the columns, or, failing that, to dispose of them with some regularity and method of arrangement.

This means that an architect must consider, so far as the interior columns are concerned, each and every story through which they pass, before he can definitely fix their location. Economy should also be considered in spacing the columns within certain limits, for the reason that, where they are placed far apart, increased weight of metal is requisite in both the supporting girders and the columns, and heavier floor beams are needed, and the greater concentrated loads at the base of columns involve a more extensive foundation.

To be taken into serious consideration also are the location and probable depth of girders supporting the floor beams. As a rule, the

depth of such girders is greater than the floor beams which they carry. They may drop a foot, and sometimes much more, below the general ceiling level. It is advisable by some means to bring this impediment into some logical and harmonious relation to the architectural and decorative treatment, whatever it is, or to find some treatment naturally growing out therefrom. But, where a story is cut up into many rooms to suit the notions and desires of tenants as to floor-space, regulated to a large degree by the depth of their pocket-books, no attention is paid to this subject.



MANHATTAN LIFE BUILDING, NEW YORK.
A TYPICAL FLOOR PLAN.

Next in order is the position of outer wall columns, which must be covered up in the piers or come in the wall spaces—anywhere except in a window. They are regulated, as a rule, by the design of the exterior, though sometimes they regulate the design. Some columns carry the ends of floor girders, and are, in a measure, fixed. Sometimes it is possible to line up all exterior wall columns with those of the interior, simplifying both manufacture and erection. But the rule as to short spans for purposes of economy, and rigidity as well, applies here too. As the walls must be supported on girders, it is vital that the spans should not be excessive, especially in cases where girders support three stories of wall.

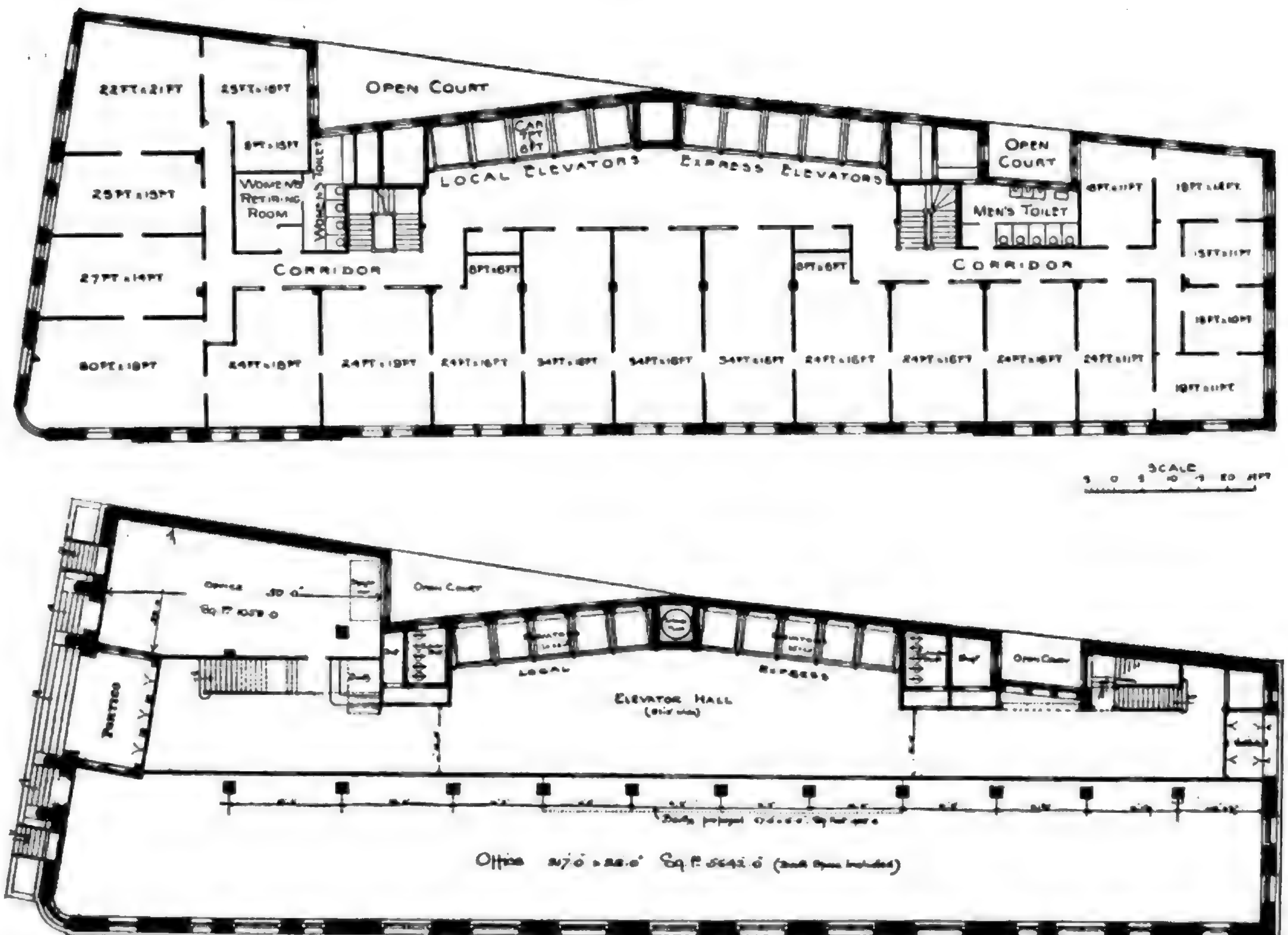
The system and character of bracing and tying together the ex-

THE CORN EXCHANGE BANK.

THE GILLENDER BUILDING.
Copyright, 1897, by Geo. B. Hall & Son.

THE ST. PAUL BUILDING.

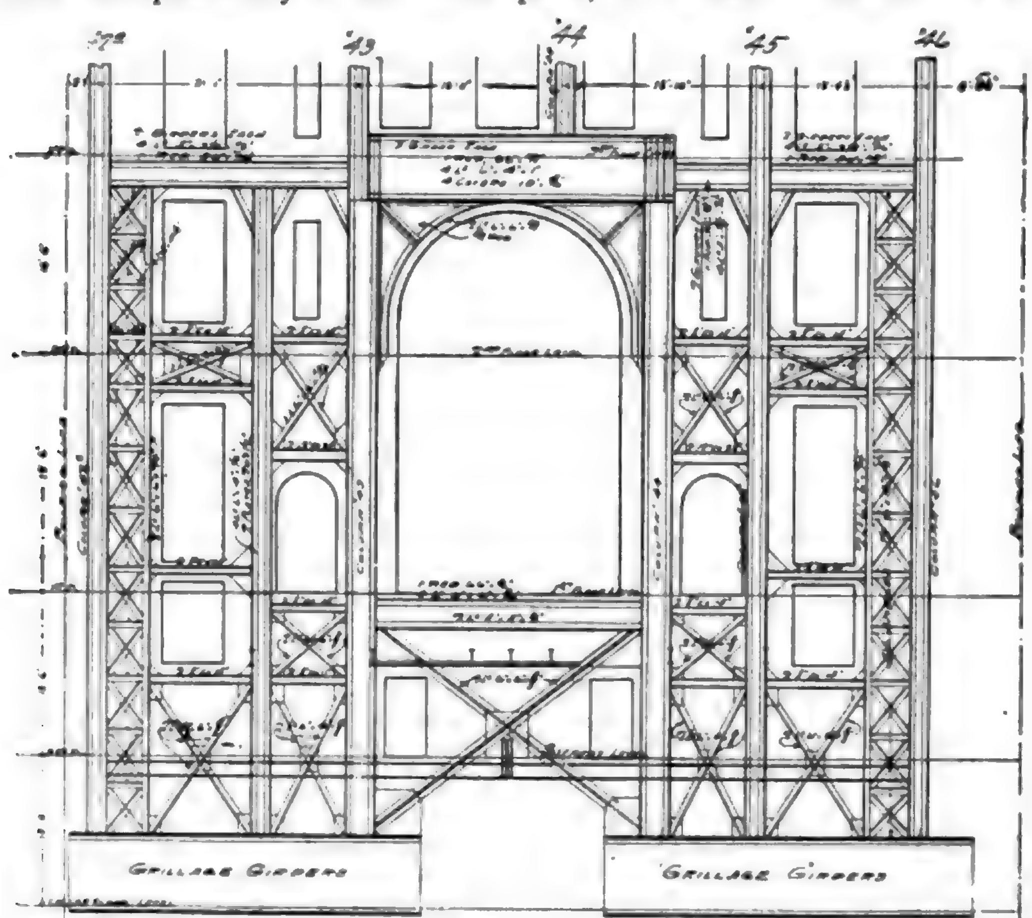
SOME RECENTLY ERECTED TALL BUILDINGS IN NEW YORK.



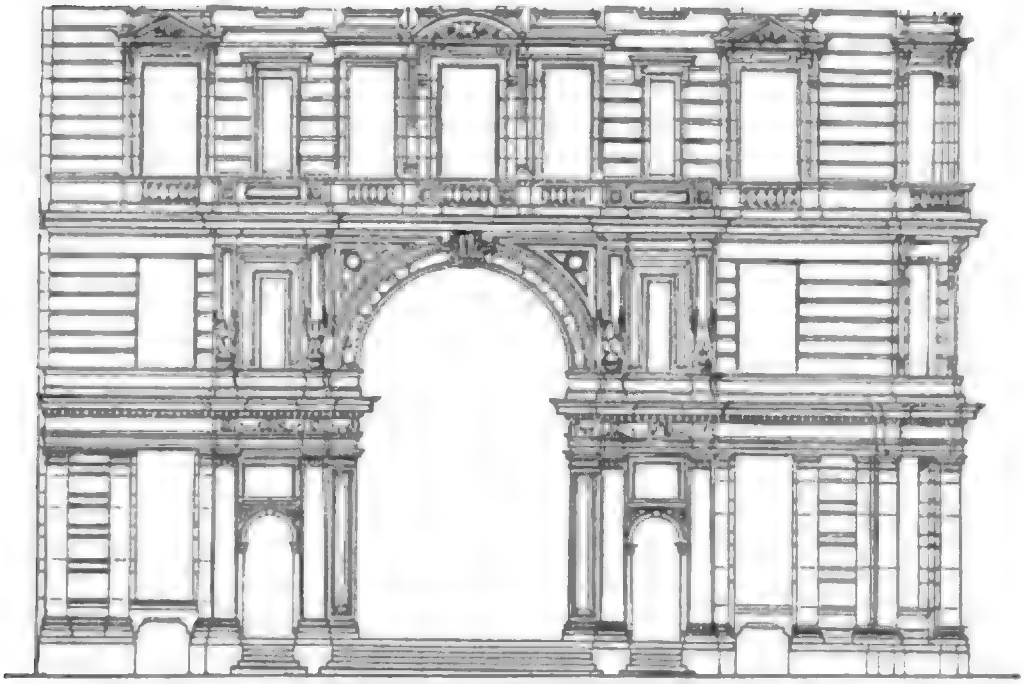
EMPIRE BUILDING, NEW YORK. FIRST-FLOOR PLAN, AND TYPICAL FLOOR PLAN, DIVIDED.

terior wall columns and girders to resist wind-pressure can, to a great extent, conform to the wall-spaces placed at the disposal of the engineer by the architect in his design, but sometimes, as in the case of a narrow frontage with long side exposure, the height of a building demands special bracing, to accommodate which there must be an adjustment of the architectural composition. The accompanying illustration of the first two stories of the Broadway front of the Empire Building, Rector street and Broadway, is an example. Notwithstanding the greatest care on the part of the architect and his assistants, it is difficult to guard against every contingency and keep the structural frame amply covered and protected.

In the placing of outside wall-supporting girders in the case of a stone front it is desirable to locate them where cornices or band courses occur, so that the heavy stone forming these features may run through the wall and be borne on the girders, thus acting as corbels on which the walls above may be carried, up to the next horizontal line of girders. This system permits the erection of any part of a front independently of the other parts, if deemed advisable. It is



EMPIRE BUILDING, NEW YORK.
Elevation of the lower part of the skeleton frame, Broadway front.



EMPIRE BUILDING, NEW YORK.
Elevation of lower part of Broadway front, as it will appear when completed.

well to say that it is not popular in this city to skip about in this manner in building an outside wall; when a start is made, whether at the first or second story, it is safer to continue to the top uninterruptedly, course by course. There is a possibility, however, that, in case of defacement or serious damage by fire, such portions may be removed and restored with greater facility than in former days.

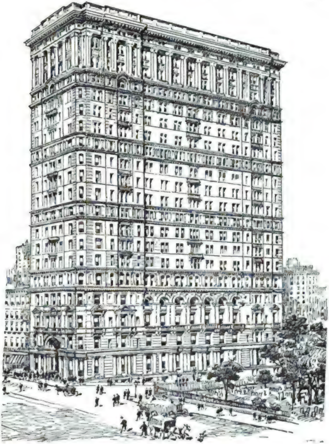
The protection of the structural frame imbedded in the outside walls has been the cause of much discussion and variety of practice. Some architects advocate placing the column supports entirely within the wall. This involves heavy bracketing out from the columns to support the girders carrying the walls, as well as a loss of floor-space, besides eccentrically loading the columns. The method most employed is to so place the column that it shall have the protection of from eight to twelve inches of masonry between it and the outer air, and treat the metal with a moisture-resisting paint or composition. Much depends on the design of the column. It will be conceded by those familiar with the subject that the best form of column is one so designed as to offer a minimum exposure in the direction from which moisture is likely to penetrate the walls. Therefore an open column, through which masonry may be built entirely surrounding the metal, the webs being placed at right angles to the walls, should secure the best and most lasting results in freedom from injury by moisture or by heat from external fires. This rule applies to girders generally, although there are conditions prohibitive of forms other than those with webs of rolled plates.

The protection by fire-proofing of all skeleton frame work, columns, girders, and beams in the interior of a building, demands nearly as much study as that spent upon their location. This is particularly true in the case of columns. An adequate water-protection must be capable of resisting the pressure of a stream from the most powerful engine. To secure such resistance, and to properly protect a column against injury by fire surrounding it, the column should be enclosed in a burned-clay blocking of at least four inches in thickness, laid in the very strongest cement and carefully bonded together at the angles. This, however, means an enlargement to eight inches more than the neat size of the metal, so that a column which, in the first story, measures twenty inches across, will increase to a measure of twenty-eight inches. This forms an obstruction difficult to dispose of in a manner eminently satisfactory to client and tenant, as the increased sectional area absorbs floor-space. Sometimes this is further augmented by the pipe lines of various sorts being carried up on the columns. It is aggravating enough to make such display of features which it is most desirable to conceal; but, when these pipe lines must be carried up on one side of a column on which a girder centers, then the architect's cup of misery is full to the brim. Very possibly he has designed and worked out an elaborate decorative treatment in the earlier stages of his work, and, just when ready to take the matter up and put it into the hands of the builders, he is compelled to begin all over again, and do something else much less satisfactory.

He finally overcomes the difficulty, and, when this is done skilfully, it is noticeable how sadly out of proportion the appreciation of his efforts is to the amount of hard thinking he has given the subject.

The tying up and effacement of all the odds and ends of protruding constructive detail, especially without incurring extra charges on the part of the contractor, requires considerable thought. It sometimes leads to irritation on the part of the client that provision for such detail was not incorporated in the original specification. But it can hardly be otherwise, for it is scarcely practicable to provide for every contingency of this nature, even where ample time is allowed, and quite impossible in the short time usually granted the architect to prepare full plans and detail drawings.

The final effort of an architect, after he has plans, design, and construction well thought out, is to devise a suitable foundation to sustain his creation. He began at the bottom and worked up to the roof to perfect the arrangement of floor-space, and then began at the roof and worked down to the cellar to perfect his construction and find out what it all weighed in tons and pounds. Now it is to be determined what the sub-structure must be. Will the nature of the



THE EMPIRE BUILDING, NOW BEING ERECTED IN NEW YORK.

ground admit of a grillage foundation, composed simply of girders and beams resting on a bed of concrete, or are the accumulative loads so great that nothing short of bed-rock will suffice to safely carry the structure? The point must be determined beyond doubt or question, and the building secured against any settlement other than the natural adjustment of the various conflicting parts. The problem has been much simplified since the introduction of the caisson found-

ations, the first of the kind being used for the foundation of the Manhattan Life Building, 66 Broadway, New York city. When the proper foundation system has been decided upon, designing of the shoes and metal base to receive and support the carrying columns must be considered with reference to bulk as well as sustaining qualities.

The installation of the generating machinery requisite to operate the several systems requiring power, such as are needed in every modern building, for heating, lighting, elevator, plumbing, and ventilation, demands provision for more than one boiler, and sometimes half a dozen. These various mechanical systems must be so disposed throughout the cellar as to work advantageously one with the other. A bulky mass of grillage, with its fire-proof enclosure, would, in many cases, seriously upset any practical arrangement of machinery, if not altogether prevent its use.

It, therefore, becomes incumbent on the part of the engineer to so distribute his loads by means of girders or cantilevers as to offer the least obstruction in the floor-space ; at the same time he must keep in mind the fact that all of these different systems require piping which must be run above and across the grillage in all directions, and that no grillage must be of such height as to encroach upon the free and uninterrupted right of way for this purpose. This may compel him to bury one or more layers of grillage under the the surface of the cellar floors, but, when this means under water, he must seriously consider the natural life of metal exposed to continual moisture, the necessity of proper protection, and the nature of the protection which will be surely efficacious in repelling moisture for a long period.

It will be apparent to the reader that an architect has much to do to design and carry to a successful issue the many problems continually arising in the erection of a large building. Only the constructive elements have been herein referred to. A thorough inspection of one of the large modern buildings from cellar to roof would best serve to show the visitor the manner in which every part has been thought out, and could not fail to impress him favorably towards the architect and those who have faithfully carried out his views.

The rapid development in electrical science, steel-construction, sanitary appliances, heating and ventilation, elevator service, in fact all that goes to make up a modern building, compels an architect to keep himself well-informed in these subjects so that he may intelligently direct the experts he may call upon to assist him in perfecting the details of their special professions. The better grasp the architect has of these subjects, the more likely he is to achieve satisfactory results.

THE DEVELOPMENT OF THE STEEL RAIL IN THE UNITED STATES.

By H. G. Prout.

A BAR of steel thirty feet long, of simple and uniform cross-section, may appear a little thing. In its effect on human happiness, however, it is a very important thing, and, as an engineering construction, it has puzzled many able minds. A past president of the American Society of Civil Engineers, who is not lacking in the sense of humor, said: "Looking at the rail on end, it is a very small affair, six or eight square inches in area, but, when looked at in longitude, we find that it is over 600,000 miles long, and every inch contains a blunder." It is my purpose to try to give, briefly, some notion of the importance of the steel rail to mankind, of the variables that have perplexed designers, of the blunders that they have made, and of the success that they have had.

A few years ago a distinguished company of foreign iron and steel workers was gathered in Chickering Hall, New York. They were delegates from the British Iron and Steel Institute and from the Verein Deutscher Eisenhüttenleute. They were visiting the United States to see some of the work done there in the noblest of the metals. The great incident of the day of which I speak was the presentation of the Bessemer gold medal to an eminent American, Mr. Abram S. Hewitt. In his address Mr. Hewitt said that "the invention of printing, the discovery of the magnetic compass, the discovery of America, and the introduction of the steam engine were the only capital events of modern times which belong in the same category as the Bessemer process." He said further that "Sir Henry Bessemer has contributed more than any other living man to that condition of industry which compels all who are engaged in its conduct to combine on a scale unknown before his time in the work of economic production and equitable distribution. A serious, if not fatal, blow at the domination of what may be termed the privileged classes of Great Britain was struck, unintentionally doubtless, by the invention of Bessemer. It is apparent that the structure of the British government will necessarily undergo very serious changes, and Sir Henry Bessemer has been the great apostle of democracy."

Mr. Hewitt meant that Bessemer had brought about one of those epoch-making changes in economical conditions that are working steadily through the generations and through the centuries to make life easier and broader for the great mass of mankind,—those changes

through which the poor and the lowly rise in knowledge, and wealth and power and the classes disappear. And this effect of Bessemer's work comes chiefly in reducing the cost of transportation.

The introduction of railroads made an industrial revolution, and nothing less; but the progress of that revolution seemed to have about reached its limit in the decade between 1860 and 1870. The further progress in economy and efficiency in the great machine of transportation called for increased weights on all wheels, and especially on driving-wheels, and the advance in public service called for greater speeds. But the iron rail went to pieces under the weights imposed upon it and under the shocks of the blows of heavy machinery at high speed. Early in the sixties it had begun to be obvious that rolled iron rails would not permit much further progress in weight and speeds. The limit of development was apparently to be found in the cost of maintenance of track, and, notwithstanding the increasing volume of production, the price of iron rails was rising. For seventeen years they had sold in the United States at an average of $57 a ton; in 1862 they were below $42, and in 1864 they jumped to $126. The price was trebled in two years. This was the result partly of the civil war, and partly of conditions affecting rails especially. The average price of gold in 1862 was 116¼; in 1864 it was 204½. A proportionate rise in rails would have carried them up to $74 a ton; but they rose to $126, and we must conclude that a very large part of this rise was from the effect of the demand for them for new work and for repairs. Train weights could go no further, and rates charged for service could be reduced no lower without ruin to the railroads. It seemed in 1864 as if the limit of endurance of railroad track had been reached, and as if progress stood confronted by one of those physical facts which sometimes stop the way for centuries.

The maximum price of iron rails was reached in 1864; but steel as a possible relief had already begun to be talked of. Ten years before, in 1854, Bessemer began the series of experiments which led to the discovery of the pneumatic process. In trying to get a good gun-iron, he perceived that cast iron might be rendered malleable by blowing air through the fluid metal. In 1855 and 1856 he took out his first patents for the pneumatic process, and in 1858 actually converted cast iron into cast steel.

But in 1857 Mushet got hold of some metal that had been de-siliconized and de-carbonized by the Bessemer process, remelted it in a crucible, added spiegeleisen, and made a steel rail, which was actually laid in the tracks of the Midland Railway, remained there for five years, and carried a million and a quarter trains. This was, so far as I can learn, the first Bessemer steel rail ever rolled.

But it took a good while to get to rolling steel rails commercially, and in 1867, ten years after the first steel rail was put into service, they still sold in the United States for $166 a ton. The American production in that year was 2,550 net tons; but from that time on the price fell fast. In 1877 it was $45.50; in 1887 it was $37; and now it is about $20. The production rose from 2,550 tons in 1867 to 432,160 tons in 1877 and to 2,354,132 tons in 1887. This was the banner year in the United States,—the year in which about 13,000 miles of new track were built. Since then the new mileage of railroads has never approached that length, and the output of steel rails in America has never been so great. In 1896 the United States built about 1,700 miles of railroad, and rolled 1,100,000 tons of steel rails.

But the steel rail came, and once more the way was clear for the progress of the industrial revolution. The first steel plant on a commercial scale built in the United States was established in Troy, and made its first blow February 15, 1865. This was established by Messrs. Winslow, Griswold & Holly, Holly being, of course, the engineer, and the man who furnished the greatest part of the science, enthusiasm, and imagination. In June, 1867, the Pennsylvania Steel Company made its first blow at Steelton, near Harrisburg, this plant also having been designed and built by Holly. From this time steel mills followed fast. The first steel rails rolled in the United States were a lot of six, rolled by the North Chicago Rolling Mill Company in May, 1865,—eight years after Mushet rolled his experimental rail in Wales. These were rolled from ingots made at an experimental plant at Wyandotte, Mich., and they were doing service in track ten years later. The first commercial rolling was at the Johnstown works of the Cambria Iron Company in August, 1867. These rails were rolled for the Pennsylvania Railroad Company from ingots made by the Pennsylvania Steel Company works at Steelton.

I have tried to give a notion of the timeliness of the introduction of the steel rail. I wish that I could stop to say something of the men who started that vast business in the United States. There are few stories so stirring in the industrial annals of the world. Reputations and great sums of money were risked on what was still an experiment. The men who invested their reputations and their money stood to make a colossal success or a colossal failure. These early steel-makers were men of ability, enthusiasm, and prodigious courage. Some of them are still alive and active, for this industry began in the United States only thirty-four years ago. I can mention, however, only three or four of them; first among them, and far above all the rest, stood Holly, the man of genius. He had the soul of the poet, the energy of the soldier, the intellectual grasp of the

philosopher. I have said that he was a genius; and his life illustrates the saying that genius is the capacity to toil terribly. He burned himself out and died at fifty, having accomplished great things, and loved by his comrades as few men are ever loved. I have often been touched by some words of his which show the vein of tender sentiment that ran through his bright and manly nature, and the apt felicity with which he could express himself. In 1879 a group of friends united to give Holly a piece of silver plate. The presentation occurred at a little party arranged for the occasion, and it was a surprise to Holly. In receiving the gift, he made a short speech, closing with these words: "Among us all who are working here in our noble profession and are keeping the fires of metallurgy aglow, such occasions as this should also kindle a flame of good fellowship and affection which will burn to the end. Burn to the end; perhaps some of us should think of that, who are burning the candle at both ends. Ah, well, may it so happen to us that, when at last this vital spark is oxidized; when this combustible has put on incombustion; when this life-fire flickers thin and pale at the lips,—some kindly hand may turn us down—not underblown; by all means not overblown—some loving hand may turn us down, that we may perhaps be cast in a better mould." Many admired his brilliant intellectual gifts; and a choice group of the best men admired him and loved him because he was not only greatly endowed, but generous, frank, modest, and devoted to duty. And perhaps of all his shining qualities this last—his devotion to duty—was the noblest.

Probably after Holly the first rank should be given to the two Fritzes, George and John, plain, uneducated men, but men of talent and character. They built up the great works at Johnstown and at Bethlehem, invented many appliances, and did much to create the Bessemer art. Captain Jones, long engineer and superintendent of the Edgar Thomson Works, was another man much like the Fritzes, a characteristic American, preëminently a self-made man, clear-headed, rugged, and resolute. He died as he had lived, at his post of duty, in a blast-furnace accident at the Edgar Thomson Works.

Robert Forsyth, another of the leaders, lately chief engineer and vice-president of the Illinois Steel Company, was sent to Chicago by Holly to superintend the erection of the original North Chicago Bessemer Works, of which he afterwards had charge. He designed the converting department for the South Chicago Works, and later rebuilt the Union Works at Chicago, and finally came to be the technical chief of the consolidated mills.

Robert W. Hunt, whom I shall have occasion to mention again, has been identified with the steel industry for thirty-seven years. He

has been an acute and enterprising student and executive man, and is to-day one of the highest authorities on steel rails. He was a lifelong friend of Holly, as well as of the Fritzes and Forsyth.

We will now trace briefly the development of the cross-section of the steel rail, and will then return and analyze the sections somewhat carefully. In the diagrams the figures in vertical column on the right give the proportion of the metal found in each of the principal members. Thus in Holly's section (Fig. 2) the head contains 37 per cent. of the total, the web 29 per cent., and the flange 34 per cent.

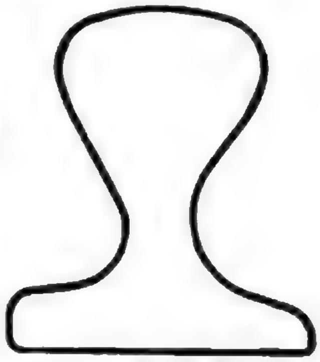


FIG. 1. IRON, 84 LBS. 1857.

It was natural that the earliest steel rails should have followed the iron rails closely. The prevailing shape of the flat-footed iron rail at this period was the pear head (Fig. 1), which had been adopted to prevent the sides of the head from breaking down; so long as one had to deal with a weak metal, it was a good section. But Holly had already grasped the idea that a rail should be designed to give better service as a beam, and he concluded that, if it was made of the best re-heated soft iron, with a thin and elastic head, and deep, as a girder, it would not only wear well, but carry well. As early as 1856 he designed a section to embody these ideas (Fig. 2). But this form, I think, was never rolled. The English mills controlled, and stuck to the pear-head for flat-footed rails rolled for export.

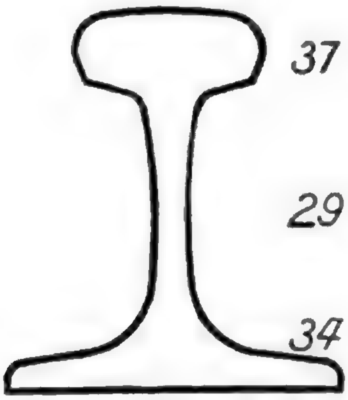


FIG. 2. HOLLY, 58 LBS., 1858.

In the United States, however, better practice began even before the era of steel. In 1864 Mr. Ashbel Welch designed a section for a 62-pound iron rail, 4½ inches high, with a four-inch base, and such an angle under the head that a fish-plate could be applied. This was very similar to his later steel section (Fig. 3). Many thousand tons of rails of this pattern were rolled, and they did good service. The half-inch stem never gave out, nor did the head or base crack off at the sharp re-entering angle, as many engineers anticipated.

In passing, I may say that Mr. Welch

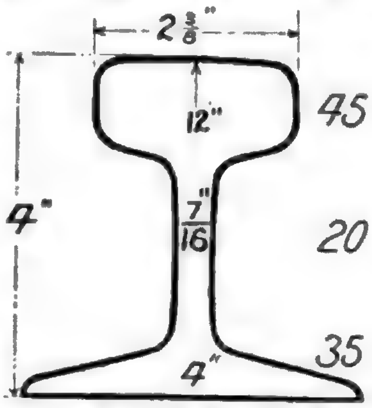


FIG. 3. WELCH, 53 LBS.

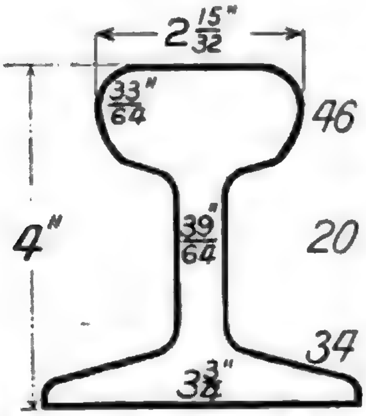


FIG. 4. MANY ROADS, 60 LBS., 1870.

was a remarkable figure in the engineering profession, and became president of the American Society of Civil Engineers. He was a man of gentle manners, but clear, analytical mind and resolute character, and was one of the longest-headed men of his generation. It often surprises me to see how, in various branches of the art of railroading, he anticipated, twenty or thirty years ago, the best American practice of to-day.

As I have said, the earliest type of steel rail was the pear head. In 1866 Mr. Welch designed a section for a steel rail (Fig. 3) embodying the ideas which he had put into the iron rail. He found it difficult to get this rolled. The great steel makers of Sheffield, John Brown & Company, tried to persuade him of the folly of it, but it was finally rolled without much difficulty, stood a remarkably good drop test, and was laid in the spring of 1867 at points where the iron rails were giving out most rapidly. These rails performed so well that they were quickly followed by others of the same pattern, and, after carrying ten million tons of freight, there was not a broken rail among them, although heavier steel rails of the older type frequently broke.

Naturally, the Welch section soon spread, and for a while it determined the type in America; but in 1874 Mr. Octave Chanute, then chief engineer of the Erie railroad, brought out a section (Fig. 7) which was the progenitor of what has been the standard type in the United States until very lately, although it was modified until in 1880 the rail mills were carrying rolls for perhaps three hundred sections, all closely resembling this type, but so far departing from it that, as Capt. Jones said, a rail mill had to have a ten-acre lot to hold its rolls. This section is generally known as the Chanute section, but the Bethlehem Iron Works rolled something very much like it for the Lehigh Valley Railroad, after the designs of Mr. Sayre, two or three years earlier. Probably, however, Mr. Sayre and Mr. Chanute designed their sections independently of each other. The essential departure from the Welch section is in the greater amount of metal in the head, the straight and somewhat flaring sides, and the thin web and flange.

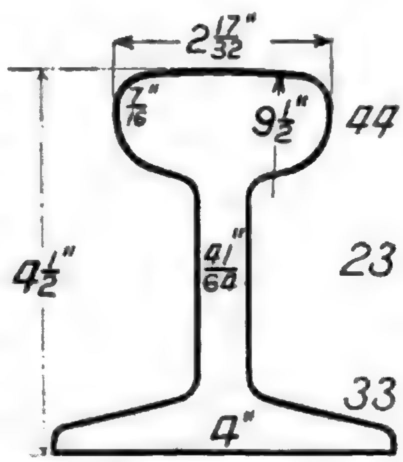


FIG. 5. P. R. R., 67 LBS., 1870.

With the Chanute-Sayre type as a basis,

engineers went on to develop rails with deeper and bigger heads, especially in the vertical dimension, with straight and sloping sides, and robbing the web and the flange for the sake of getting metal in the head of the rail, where the wear came. But presently a new school of design sprang up; people began to discover that the steel rails with big heads actually did not wear as well as the light John Brown rails and other rails of English and American make rolled to the Welch section; and it began to be suspected that the fault was in the design of rail rather than in the chemistry of the metal or the mill processes. In 1883 Mr. P. H. Dudley designed for the New York Central & Hudson River Railroad an 80-pound rail (Fig. 11) which was an important departure from the common practice. He made this rail five inches high, and gave it a broad and shallow head. This design marked an epoch in rail sections, and, while it is difficult to ascribe exactly the credit due to each man in the change which gradually followed, it is certain that Mr. Dudley has had great influence in bringing about the present section. It must be kept carefully in mind that I speak now of Mr. P. H. Dudley, of dynagraph fame. Mr. Hawks, chief engineer of the Michigan Central Railroad, came out in 1889, with a rail (Fig. 12) similar in design to Dudley's. In both of these rails the characteristic departures from previous design are found in the head, relatively broad and thin, and with such a distribution of the metal as makes what has come to be called a balanced rail; that is, the percentages of metal in head and flange are approximately the same. In 1889 also Capt. R. W. Hunt brought out designs for a series of rails, weighing 60, 65, 70, 75, 80, 85, and 90 pounds, with the general characteristics shown in the sections devised by Mr. Dudley and Mr. Hawks.

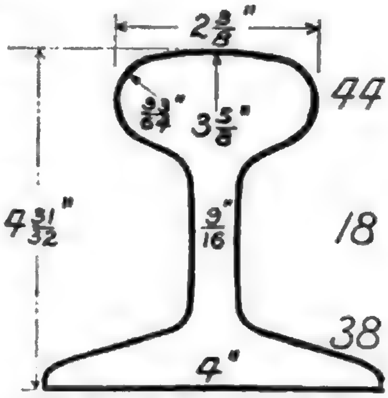


FIG. 6. D. L. & W., 61 LBS., 1874.

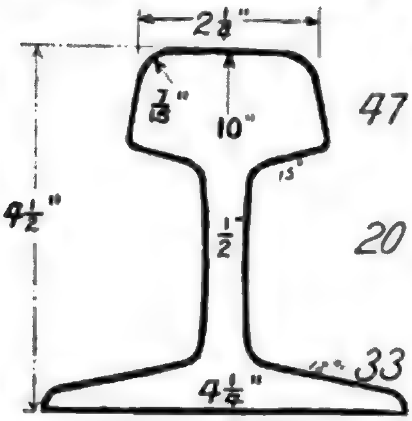


FIG. 7. CHANUTE.

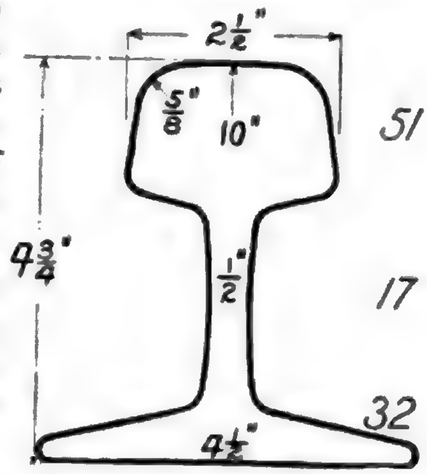


FIG. 8. P. R. R., 75 LBS., 1885.

In the period between 1883 and 1889

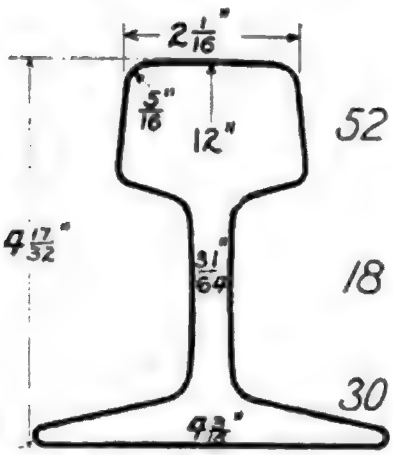


FIG. 9. C. C. C. & I., 65 LBS., 1885.

there had been a good deal of discussion of the proper section of rail (Dudley, Hunt, Hawks, and a few others taking the burden of the argument), which resulted in the appointment in 1890 of a committee of the American Society of Civil Engineers, instructed to present to the society designs for what might be adopted as a series of standard sections. This committee, after long consideration, presented in 1893 a series ranging from 40 up to 100 pounds at 5-pound intervals, and this series is nearly identical with the designs of Hunt and Hawks (see Figs. 14 and 15). Mr. Dudley, however, who was not a member of this committee, brought out in 1890 a complete series (see Figs. 16 and 17 for types) embodying his ideas, which differ slightly from those of the committee of the Society, although designed on the same general principles.

We will now again run over the record of rail sections, and analyze the types, one after another, with a view to getting at the logic of them, and determining in our own minds who, of the various designers, has come nearest to the absolute truth.

Mr. Welch's section (Fig. 3), the first serious departure from the pear-head type of rail, was designed with a view to a rational use of the superior material. The pear-head form had been used to prevent an inferior rail from going to pieces, and it was an excellent form in which to roll slag and cinder, and the baser metalloids. Mr. Welch conceived that, with steel, it would be possible to adopt proportions in which the metal should be disposed to give the greatest endurance against abrasion. Thus a thin stem and base would give sufficient strength, while the mass of the metal could be put in the head. This shape also gave surfaces to which the fish-plate joint could be applied under the head, doing away with the necessity for laying the end of the rail in a rigid cast-iron chair resting on a tie,—a method which subjected the rail to a blow between a heavy hammer above and an anvil below. He designed, therefore, a rail 4 inches broad at the base and 4 inches high, with a head 2⅜ inches wide and 1¼ inches deep,

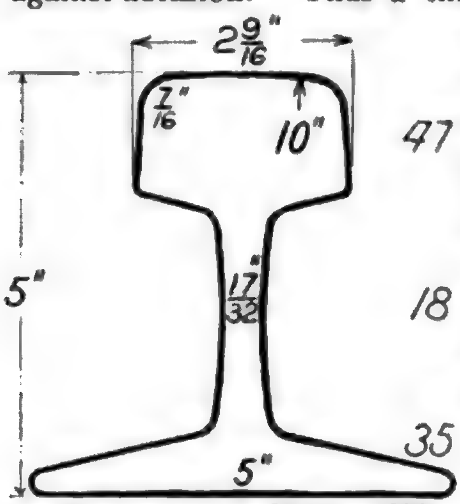


FIG. 10. P. R. R., 85 LBS., 1888.

giving the top a curve of 12 inches. The stem was only $\frac{7}{16}$ of an inch thick, and the fishing surfaces under the head and on the top of the flange were inclined at an angle of 14 degrees with the horizontal. I do not discover that Mr. Welch went much further than this in elaborating the theory on which his rail was designed, but it is singular that in so many particulars he came, in this very early type, close to the form which now prevails in the standard recommended by the committee of the American Society of Civil Engineers, and which embodies the fundamentals of the Dudley-Hawks-Hunt sections. In the distribution of metal he got more in the head and less in the flange than the Civil Engineers' standard series,—that is, 45 per cent. in the head as against 42, and 35 in the flange as against 37. The radius of the crown is exactly that adopted in the latest standards,—namely, 12 inches. The width of the head between the origins of the corner curves is but ⅛ of an inch less than in the Civil Engineers' 70-pound rail, and is ⅛ of an inch more than in their 55-pound rail. The Hawks 80-pound rail has almost precisely the proportions of the Civil Engineers' section, and, so far as the distribution of metal goes, is very close to Mr. Welch's section of 1867. Mr. Welch does not seem to have gone into the chemistry of the rail, or to have considered very much the effects of his proportions upon the physical quality of the metal after it passed through the rolls; this was natural, for the whole science and art of steel-rail making was developed after his section was designed. Considering that he worked in the very dawn of that science and art, before a single principle had been established, it is wonderful that he should have come so near to what seems now the best American practice. And this is another instance of the singular clear-headedness and far-sightedness he so often displayed.

The Welch section had a great influence on the early steel rails, and soon determined their proportions, so far as American practice went. The three early designs (Figs. 4, 5, and 6) are

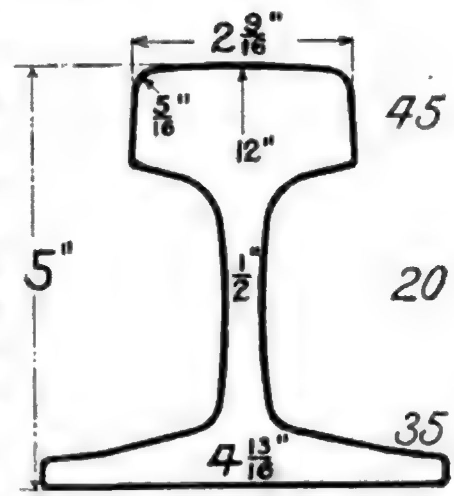


FIG. 11. DUDLEY, 80 LBS., 1883.

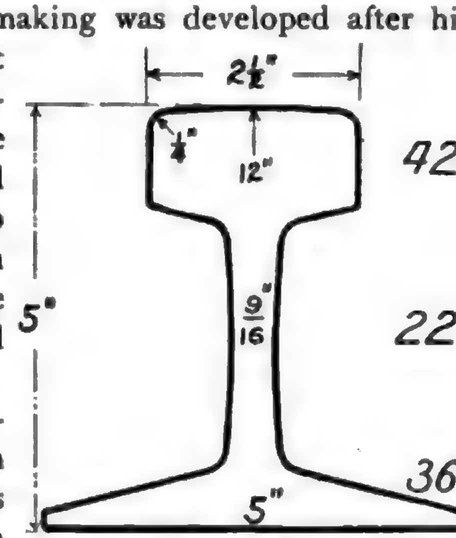


FIG. 12. MICH. CENTRAL, 80 LBS., 1889

interesting departures from the Welch section. The 60-pound section of 1870 was very popular. The effort to get a fishing angle under the head is observable, and it will be seen that the weight of metal in the head has been increased very slightly beyond Mr. Welch's design. The Pennsylvania Railroad 67-pound rail of 1870 is essentially the Welch section. The Delaware, Lackawanna & Western 61-pound rail of 1874 is chiefly remarkable for the very short crown radius,—namely, 3⅝ inches, which, I suspect, is a mistake of some draughtsman or printer. The very unfavorable fishing angle is also noticeable.

Then came the Chanute-Sayre school, about seven or eight years later. Mr. Chanute (Fig. 7) reasoned that the place to put precious and costly steel (rails in that year being worth $68.75 a ton in the United States) was where the wheel-wear came,—that is, on the top of the head. Therefore, he piled up a deeper head than had prevailed in the progeny of the Welch section. The percentage of metal rose from 45 to 47 in the head, and fell from 35 to 33 in the flange, the web remaining the same. The width of the top of the head diminished slightly, the crown radius was shortened 2 inches, and the sides of the head were bounded by straight lines and were flared. The prevailing idea was to put the metal on the top of the rail, where the wheel wear came. Precisely why the crown radius was reduced to ten inches I do not remember; perhaps Mr. Chanute did not explain. Presumably, however, it was partly because that radius lent itself to a higher head, and partly because he discovered that the rails in service tended to wear to this radius. The flaring of the sides was to give a greater fishing surface under the head. Singularly enough, he adopted two different angles,—15 degrees under the head, and 12 degrees on the top of the flange. This doubtless was for some sufficient theoretical reason, which it would now be a waste of time to inquire into. Observe, too, that Mr. Chanute makes the upper corner radius of the head $\frac{7}{16}$ of a inch. These points of the $\frac{7}{16}$-inch radius and of the flaring sides should be kept in mind, because we shall have something more to say about them presently. The Chanute-Sayre section fast prevailed as against the Welch section, and became the typical section, although engineers departed from it in large and small particulars, each man designing his own section. In 1880 Holly estimated that there were about three hundred sections more or less in use in the United

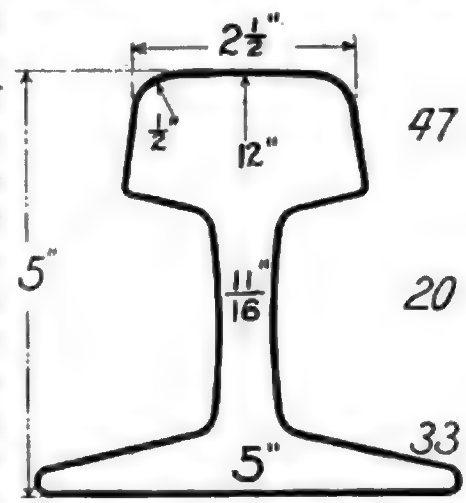


FIG. 13. P. & R., 90 LBS., 1888.

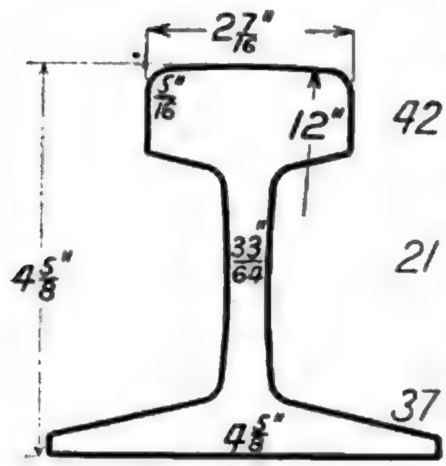


FIG. 14. AM. SOC. C.E., 70 LBS.

States. About 1890 I tried to form an idea of the variety of sections. I found that in four of the large mills rolls were carried for twenty-four different sections of 60-pound rails alone, and that there were twenty-nine different weights between 56 and 85 pounds. There were rails weighing 58 pounds, 58¼ pounds, and 58½ pounds per yard; again, 66, 66½, 67, 68½, and 69 pounds. As nearly as I could get at it, these four mills must have carried rolls for more than one hundred and eight different sections, for rails upward of 56 pounds per yard and in current use, besides still other rolls for sections that were then obsolescent. It is astonishing, in looking over the section-books of the rail mills, to see the trivialities in which the engineers departed from other men's designs, in order to put their names on their own sections. Thus we find the widths of flange measuring $4\frac{5}{64}$ inches, $4\frac{1}{32}$, and $3\frac{15}{16}$; one man, who preferred the decimal notation, actually carried his flange width out to five places of decimals. Of course there could be no possible engineering reason for such refinements, even if rails could have been rolled with such nicety. They make one think of John Phœnix's celebrated case, in which the engineer paced the diameter of the circle and then multiplied it by π carried out to 14 places of decimals. Holly's explanation of this rage for thirty-seconds and sixty-fourths was that it was largely a matter of human vanity; that it was very gratifying to Stiggins to have the rail mills and the chief engineers of various railroads study the drawings of Stiggins's section. But, whatever the reasons, the result was waste of human energy, one of the greatest of modern crimes. Every time a rail mill got a new order, it had to change its rolls. There was no possibility of rolling standard sizes of rails and stocking them, and thus equalizing the output, which is obviously one source of economy. And the misery of the situation was that no earthly good was served by this variety. Fortunately, owing largely to the

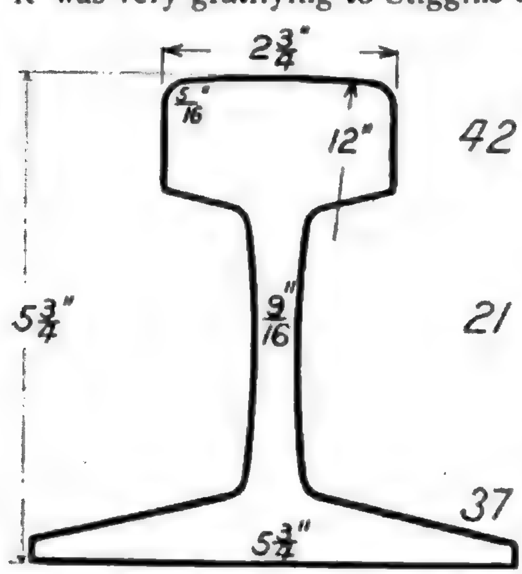


FIG. 15. AM. SOC. C. E., 100 LBS.

labors of Dudley, Hawks, and Hunt, of the committee of the American Society of Civil Engineers, aided somewhat, I trust, by one or two editors, the tendency is now towards simplicity and uniformity.

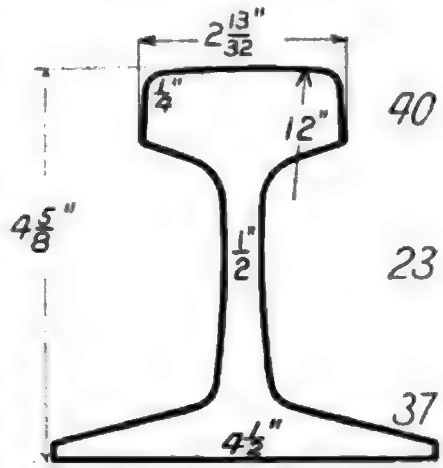


FIG. 16. DUDLEY, 56 LBS., 1890.

But let us return to the Chanute section. It was brought out in 1875. It quickly became, with slight modifications, the standard of the Erie. By 1885 it had taken such forms as that of the Pennsylvania Railroad (Fig. 8). This is a 75-pound section, larger in all dimensions than Mr. Chanute's 62½-pound section. The piling up of metal in the head has gone on, until the Pennsylvania rail has 52 per cent. of its total weight in the head. The crown radius remains 10 inches; the width from out to out is 2½ inches; between the origins of the corner curves it is less than 2¼ inches. The corner curve has a radius of ⅝ of an inch, thus making the top even more convex than in the Chanute pattern. In 1888 the Pennsylvania people brought out an 85-pound rail (Fig. 11), in which, for some reason or other, they returned to what, in the light of the present day, seems to be rather better proportions, but not much better. The metal in the head is still 47 per cent. of all, and the crown radius is 10 inches, but relatively the head is a little broader, and not quite so deep. A glaring case of the bad influence of the Chanute-Sayre theory is shown in the 65-pound rail of 1885 of the C. C. C. & I. (Fig. 9). Here the metal in the head is 52 per cent. of all, and the top between the points of origin of the upper corner curves is only 2 1/16 inches wide. Fortunately, the designer reduced the upper corner radius to 5/16 of an inch, and increased the crown radius to 12 inches, thus getting a fairly good crown. If he had not done so, the narrow head which he designed would have been much worse than it was.

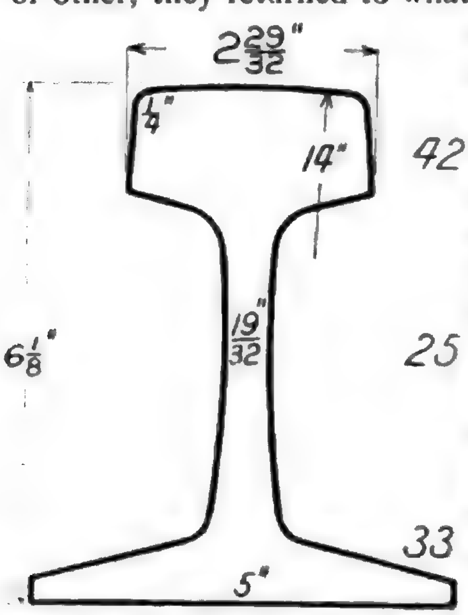


FIG. 17. DUDLEY, 100 LBS.

This short review of the history of the steel rail has brought us up to the epoch-making change which may be said to have had its beginning about ten years ago. Another article will treat more specifically of the reasons for that change, and of its results.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

II.—COST-REDUCTION AND LABOR-SAVING BY ELECTRIC APPLICATIONS.

IN all American machine-shop practice, labor is the item of expense which must be most carefully watched. Hence labor-saving machinery of every kind is employed to keep down the wages-cost of manufacture. The use of electric motive power has proved exceedingly important in this work of economy, and, as its applications are made the subject of more careful study, it will effect greater and greater saving. At present its use is growing rapidly, but it is generally directed toward only the more obvious tasks.

It is interesting to recall that the first electric motor ever put into commercial use was for the specific purpose of saving manual labor. This was at a beet-sugar works at Sermaize, near Paris, and it is recorded that during the winter of 1878, while it was in use working a small hoist for unloading beets at the river-front, it saved no less than forty per cent. of the previous cost of unloading, and handled four thousand tons of beets. The saving must have given a pretty good return on the investment.

Hoisting is obviously a work to which mechanical power can be applied with great advantage, and, from the ease with which electric power can be transmitted to moving motors, it has come into very extensive use for this purpose. For most such work it has great advantages over other methods of applying power, although for certain purposes the smooth celerity of the pneumatic lift knows no equal. Large numbers of electric hoists, derricks, and travelling-cranes are now in use in all sorts of manufacturing establishments, and the time and labor saved by them reach a prodigious aggregate. One gets a vivid idea of it in watching an electric travelling-crane, worked by a skilful operator, pick up a five-ton casting and shoot with it to the diagonally-opposite corner of a big shop, working all three motors at once, and finally land it precisely where it is wanted, without a perceptible jar.

Similar in function are the electric tramways, which have now become common in extensive works, shifting material from shop to shop, and taking machines on their way to completion through the course of travel that modern methods of subdividing labor (sometimes carried too far) seem to necessitate.

These applications of electric power are of the cruder sort, dealing with familiar problems in a somewhat commonplace fashion, but they

FIG. 1. MAGNETIC-MOUNTED ELECTRIC DRILL.
The Portable Electric Drill Co.

are tremendously effective in saving expense. Much more interesting, although used at present on a far smaller scale, are some of the devices used to facilitate particular mechanical operations.

One of the neatest applications of this sort is the employment of portable electrically-driven drills. Holes have to be drilled in masses of metal of all sorts of odd and inconvenient shapes and at all sorts of angles. In many cases the common drill press cannot be used at all, and then it becomes necessary to rig clamps to hold the drilling machine to its work, after which the drill is laboriously worked by hand. If many holes have to be drilled, this work is very slow and costly; so it occurred to some one to drive the drill by a portable electric motor, and so do the actual boring as rapidly as if the work could be mounted on a drill press.

An apparatus of this kind was introduced a few years ago in the Brooklyn navy yard, where several of the new cruisers were being built. It consisted of a portable motor, neatly boxed in and connected to the drilling machine by a long flexible shaft. The drill was clamped into place, and the work then proceeded very rapidly. Several of these machines were at work on the frames of the cruisers, drilling rivet-holes. Another was successfully used in enlarging the port-holes in the turrets of the monitor Miantonomah. Steel armor plate a foot thick or so is not the easiest thing in the world to cut, and, when the port holes had to be increased some inches in diameter to accommodate the new 10-inch rifles, by boring out an elliptical ring of armor, the task was most forbidding. But one of the electric drills was set in place, and it kept boring away until the port was completed.

A more recent type of drill for ship work is that shown in Fig. 1. In this case a still further simplification is accomplished by giving the motor and its worm-driven drill a universal mounting upon four adjustable magnetic feet. When placed fairly upon a ship's plates, these have an adhesive force of nearly half a ton each. The drill can then be adjusted and clamped, and will then bore holes up to an inch in diameter as fast as it can be safely worked. The whole affair weighs

only about 220 pounds. Portable drills of similar character are considerably used abroad.

These portable drills, particularly when the clamping is magnetic, save an immense amount of time, and could be very profitably used in many metal-working establishments. A small size, such as could easily be moved about a single man, would be invaluable in general machine-shop practice and in modern building work. The main requirements are portability and a quickly-adjustable magnetic clamping system. A portable metal saw built on similar lines should occasionally prove useful.

Before drifting too far from the subject of cranes, I should note a very clever contrivance in use in the South Chicago works of the Illinois Steel Company. In the rolling of boiler plates, the resulting sheets—say, three feet wide and twenty or more feet long, weighing from a quarter to half a ton—are very inconvenient to handle, and, when they must be moved, are very inconvenient to sling. The electrician of the works, who has distinguished himself by various neat applications of electric motive power, promptly came to the rescue, and fitted the mechanical travelling-crane in the plate room with a magnetic grip. A pair of powerful electromagnets are dropped down upon one of the long plates, which, thus held at two convenient points, is sent flying down the room and dropped into place, saving a deal of labor. In any case where many iron masses of moderate weight have to be carried on travellers this magnetic grip saves much trouble; it takes hold hard and instantly, and lets go when desired, without the bother of unhitching.

A more directly mechanical labor saving application of electric power may be found in the electric working of various automatic machine tools. Large saving is effected by the use of tools so arranged as to require little attention while running, and these machines have come into extensive employment. A case in point, where electric power has been very judiciously employed, is the cutting-off lathe shown in Fig. 2. It is driven by the small motor mounted directly upon it, whose speed is automatically varied as the feed progresses. As the tool works in toward the center of the bar, the motor speed rises, so as to preserve a constant cutting-speed of about thirty feet per minute. This device minimizes the time necessary for a cut, and the machine requires little labor of attendance. Some experiments with heavy lathes show that a direct motor drive enables more power to be concentrated in the machine than can be conveniently applied to the same size of lathe by the ordinary method of belting, so that heavy cuts can be taken more expeditiously,—in fact, up to the limiting speed which the tool will stand.

As an obviously useful addition to the automatic class of machines, magnetic clutches and cut-offs can often be advantageously used to cut off the power and put the machine out of service when its work is, for the time, done, or reverse it when necessary. In fact the electromagnet may be, and often is, used in automatic machines to simplify what might otherwise be a very complicated mechanical motion. Nevertheless experience has shown that such devices must be used with great caution, for, while thoroughly reliable under good conditions, contacts will wear out and get rough, so that the ceaseless repetition of a single small motion had generally better be effected mechanically, if possible.

It should be noted that ease of application to automatic adjustment is sometimes a good reason for using directly-driven electric tools, even when no particular saving in power can be made.

In another class of cases it is desirable to have delicate control of the speed, and this is obtained more easily and conveniently by changing the speed of the motor than by any arrangment of cone pulleys or variable gears. An ordinary shunt-wound motor with a capacious rheostat in the field circuit gives very perfect speed-control over a

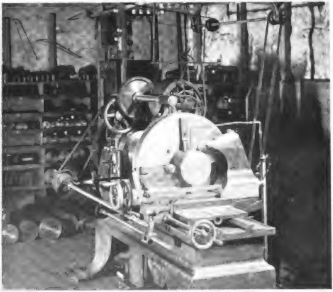


FIG. 2. ELECTRIC-DRIVEN CUTTING-OFF LATHE.
General Electric special shunt-wound motor.

moderate range, and, assisted by cone pulleys giving, say, three speeds, enables very delicate adjustment of the speed to be made over the entire working range. Special shunt-wound motors give this control over a considerable variation, unaided by any change in the pulleys, and in extreme cases the assignment of a small special generator to feed the motor at any required voltage gives a very perfect control of the speed over almost any required range. Fig. 2 shows an instance of this method of regulation.

FIG. 3. ELECTRIC SOLDER-IRON.
Ward-Leonard Co.

Another and most interesting labor-saving application of electricity may be found in the department of electric heating. It now and then happens in mechanical work that a constant and very portable source of heat is necessary. It goes without saying that, in mere cost of heat, cheaper sources can be found than electric current. But, when, for instance, a very large amount of soldering has to be done, much time is lost in changing irons, and in working with irons not just at the proper temperature. Under such circumstances an electrically-heated soldering iron facilitates operations immensely. It is always hot, and always just hot enough. Consequently these tools have proved useful. The first application of them ever seen by the writer was in soldering the caps on full cans of kerosene for export, in which case the irons had to be heated in another room until electricity came to the rescue. Fig. 3 shows a modern iron for general shop-work. In other shops an electrically-heated solder pot and ladle shown in Fig. 4 has proved useful in extensive soldering, relining bearings with Babbit, and the like, keeping the metal always at the best working temperature. The extreme ease with which electrically-generated heat can be regulated is not infrequently a great economizer of time and trouble—which means money. A capital example of such use is found in the electric vulcanizer for bicycle-repair shops, which keeps the tires just hot enough for the purpose without special attention. Every bit of human care that can be avoided means wages saved, and, while these heating devices may

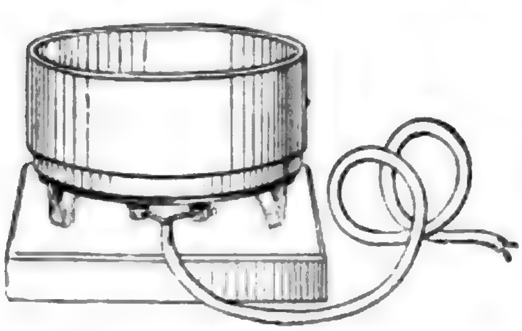


FIG. 4. ELECTRIC-HEATED SOLDER-POT.
American Electric Heating Corporation.

at first sight seem almost trivial, they do save the time of the workmen. These are typical of not a few other applications of electric heating, all tending to minimize attention to things outside of the mechanical process in hand. I note that they do not save anything in cost of heat, and are to be regarded as purely labor-saving contrivances,

FIG. 5. ELECTRIC HEATED GLUE-POT.

In general, it is very often suggested that the use of electric power, with its great convenience of application, steadily tends to get more and better work out of the workmen. In a measure this may be true, and yet in many cases electric driving is really no more convenient than ordinary belt-driving. It is quite as easy to move a belt-shifter as to start a motor ; in fact, the latter process requires rather more attention than the former, and it is doubtful whether the moral effect, so to speak, of electric driving produces any permanent effect on the efficiency of the men.

The greatest single source of saving in labor among all the applications of electricity in shops is really electric lighting. Good, clear, steady illumination is of itself valuable, and the ease with which incandescent lamps can be adjusted to throw a steady and brilliant light upon the work in the evening or during the twilight hours of a winter's day is a very important advantage. Men will do more and better work with electric light than with any other, for their attention can be concentrated on the mechanical process without the distraction of straining the eyes in an indifferent light.

For machine-shop lighting the ordinary arc light is a nuisance from the intensity of the shadows thrown by it, and the consequent sudden contrasts between brilliant, glaring illumination and intense obscurity. If the work requires very complete lighting, inverted arcs with large reflectors give the nearest approach to daylight that can be obtained by any artificial means. As the luminous crater of the arc is directed upwards, the real source of light is a dead white reflector, three or four feet in diameter, suppressing all glare, but illuminating most thoroughly.

In default of this, or to supplement it in extreme cases, excellent work can be done by incandescents supplied with reflectors and suspended over the machines on universal brackets. The ordinary flexible cord is not enough, except in cases where the work is always the same for a given machine ; for, if the light is wanted in a special position, a quickly-adjustable support is necessary.

The uses of electrical appliances directly for saving labor without material change in methods of work are thus not as general as one at first thought would suppose. Aside from saving in cost of power, the greatest gains are shown in cases where labor is saved by a new process, rather than by the adaptation of electricity to an old one. The most striking exception to this rule is in the line of tramways, hoists, and cranes, already discussed. In any machine-shop work where much material has to be moved, or heavy objects have frequently to be handled, the economist should at once turn, in most cases, to electric power. In large works it is sometimes startling to note the distances that have to be travelled by a machine and its component parts from the time the raw material enters the gates until the finished product leaves the shipping-room. All this travel is wasted work, which has to be paid for, and rather dearly if only manual labor is applied to it. It is one of the disadvantages of the extreme subdivision of labor that can be obviated only by cheapening the process of carriage. As a rule, the installation of electric apparatus for doing all this work will pay well.

Aside, then, from the savings to be effected by lessening the power-cost of production, discussed in a previous paper, we may set down electric portative devices as the most direct method of lessening the labor-cost—a method which may advantageously be coupled with general motor service, even if no further special applications are contemplated. In investigating a concrete case with reference to the adoption of electric power, this is one of the first points to be considered. If the shop examined is one where artificial light has to be used to any extent, there is a strong added reason for using electricity, unless a lighting circuit has already been installed.

The next step is to examine into the matter of special machines. The merits of the case depend largely on the class of work being done, and the extent to which the machine tools are systematically used. If a given machine, when in use, is turning out a routine product at a uniform speed, electric driving from the labor standpoint has no particular reason for being. If, on the other hand, it is being used for a large variety of purposes and at all sorts of speeds, it may well happen that merely the matter of speed regulation, enabling the tool to be worked at its most advantageous rate of cutting all the time, will show good reason for electric driving. Again, in cases where a single man tends several semi-automatic machines engaged even on uniform work, the use of electricity may render it possible by automatically changing the feed or speed, or even by automatic stopping on the completion of certain work, to lessen the attention required, and so give a single man command of more machines, or at least quicken the work of those

already in use. This line of improvement has not been followed far in general machine practice, and deserves much more attention than it has received. We have plenty of automatic machines for special purposes, but comparatively few that can be turned to a variety of purposes.

Again, the question of portable tools has a very various degree of importance in different shops. In most shops doing heavy work it has great weight, while in those turning out a light and uniform product it can hardly be considered of much importance. The electric drill has already been discussed, and, while even now considerably used, would really fill a very useful place in most large machine shops. In some cases portable metal saws and milling tools, emery wheels, and buffers, would prove exceedingly convenient, and would save a great deal of work now done with cold chisel, scraper, and file. To all such devices electric power lends itself with extraordinary facility, and there are few shops were portable tools of such a kind would not prove highly economical of labor. It is a field that can profitably be explored by the inventor as well as the engineer.

Finally, we come to a class of electrical applications which have to do not so much with an improved application of existing tools as with the convenience of the skilled workman, whose time is far too valuable to waste. Such are in themselves often apparently trivial, like the electrically-heated soldering iron, or even a magnetized screw-driver to facilitate certain assembling work, but they do save time, and time is money, if anywhere, in manufacturing-processes requiring much manual labor.

And, aside from all this, there is a further field for applied electricity, greater and more interesting than any of these—the changing, not of motive power or implements, but of methods. The mechanical arts have already been enriched in this wise by the labor of many investigators, and as yet we have seen but the beginning. Of this beginning and its lessons I will speak briefly in the next paper.

BOILER-SETTING AND FURNACE-CONSTRUCTION.

By Edgar Kidwell.

IN engineering, as in art, perfection of the whole implies perfection of all the details. In a steam plant every component part, from the coal-pile to the engine fly-wheel, has its effect upon the efficiency of the whole, and the relative weight of such influence must, therefore, be carefully studied by the designer. That this fact is becoming more fully appreciated is evidenced by the increased attention now paid to that part of the steam plant which was formerly the most neglected,—the boiler. Safety, economy, and convenience in operation, and adaptability to the general requirements of the plant, are all now considered, and frequently to the exclusion of the question of mere cost, which, until recently, was the governing factor in the problem of boiler-selection.

If this problem has been solved in favor of the return tubular, or one of the usual forms of sectional boiler, the next step is to provide a setting which is efficient as a producer of combustion, durable under continuous hard firing, and capable of being quickly and cheaply repaired. To point out the lines upon which such a setting can be designed is the object of this paper.

The efficiency of furnace and setting depends largely upon correct proportioning of parts. Concerns selling boilers the acceptance of which is subject to the performance of some specified guarantee usually know from long experience the best proportions for the setting of their boilers; hence their advice should not be disregarded, except for forcible reasons. On the other hand, it must be remembered that a manufacturer will be reluctant to advise a detail which, though known to him to be the best, may, on account of increased cost, prevent him from making a sale. No amount of oversight can obviate occasional errors. The cheapest place to correct these is at the desk or drawing-board; hence it is good business policy to check up all the important dimensions before erection begins. The wide range of conditions encountered in practice renders it impossible to treat here every detail, irrespective of the kind of boiler and the circumstances under which it is to be operated, but the following discussion covers the most important details, especially of return tubular boilers, where no unusually novel conditions have to be met.

The grate area depends upon the height of chimney, kind of fuel,

and quantity to be burned per hour. Considering 30 pounds of water evaporated per hour as one boiler horse-power, and that one pound of coal evaporates from 10 to 7½ pounds of water, 3 to 4 pounds of coal per horse-power per hour must be burned. To provide for use of inferior fuel in emergencies, it is advisable to put this figure at 4 pounds.

Isherwood's experiments show that, with natural draft, the maximum number of pounds of average size anthracite that can be burned per square foot of grate per hour for chimneys up to 110 feet high is as given in Column II, Table I. These correspond very closely to the formula $W = 2\sqrt{h} - 1$, in which W is pounds of coal per hour per square foot of grate, and h the chimney height in feet above level of grate; from this the other values of W up to h = 200 feet have been computed. For bituminous coals the maximum value of W is about $2.25\sqrt{h}$, which gives Column III.

TABLE I.

MAXIMUM WEIGHT OF COAL BURNED PER SQUARE FOOT OF GRATE PER HOUR, WITH NATURAL DRAFT.

I. Chimney Height. Feet. h	II. Anthracite. Lbs. W	III. Bituminous. Lbs. W	I. Chimney Height. Feet. h	II Anthracite. Lbs. W	III. Bituminous. Lbs. W	I. Chimney Height. Feet. h	II. Anthracite. Lbs. W	III. Bituminous. Lbs. W
50	13.1	15.8	85	17.4	20.7	140	22.6	26.6
55	13.8	16.7	90	18.0	21.4	150	23.4	27.4
60	14.5	17.4	95	18.5	21.8	160	24.3	28.4
65	15.1	18.0	100	19.0	22.5	170	25.0	29.3
70	15.8	18.9	110	19.5	23.6	180	25.8	30.1
75	16.4	19.6	120	20.0	24.6	190	26.6	31.0
80	16.9	20.1	130	20.9	25.7	200	27.2	31.7

This table presupposes a chimney section equal to one-eighth the grate area,—a proportion which cannot usually be observed when a boiler is to be connected to a chimney already built. Further, the rates of combustion above given cannot be expected with the smaller sizes of coal, or when many boilers discharge into long smoke-flues. Not more than eighty per cent. of the tabular values, therefore, should be counted upon; hence the grate area will be

$$\frac{4 \times \text{Boiler Horse-Power}}{\frac{4}{5} \times \text{W from Table,}} = \frac{5\ \text{HP}}{\text{W}};$$

or, in words, multiply the boiler horse power by 5, divide the result by the appropriate tabular value, and the quotient is the required grate area in square feet. The tendency is to make grates too large; sizes obtained as above should not be exceeded, except on the advice of an expert. When either hard or soft coal is to be used under the same boiler, according to fluctuations in market price, the grate should be proportioned for anthracite. For wood the grate area

should be the same as for soft coal, but the furnace ought to be not less than 36 inches deep in order to permit carrying a fire 2 feet thick. Width of grate should be about equal to the diameter of the shell, and not more than 3½ feet of this width should be allowed for one furnace door. The most convenient distance between the grate or dead plate level and floor line is, for a man of average stature, about 26 inches, and a variation of over 4 inches on either side of this figure should not be permitted.

FIG. 1. SINGLE GRATE-BAR.

The clear space between grates and the shell or water tubes must be such that the air and gases can be thoroughly mixed and burned. A small distance permits the shell more readily to absorb the heat radiated from the incandescent fuel, but it cools the gases before combustion is completed, thereby causing smoke and waste. For anthracite a clear height of 2 feet gives the best results; less than 18 inches is hardly permissible. For ordinary bituminous coals 27 to 30 inches should be allowed ; if the coal contains an unusually large percentage of volatile constituents, as much as 32 inches may be necessary, though in such cases it is better practice to spring a fire-brick arch over the top of the furnace. This prevents premature cooling of the gases, and facilitates combustion, so that a height of 18 to 24 inches will answer ; but more should be provided, if possible. Where either hard or soft coal must be burned under the same boiler, a distance of 26 inches between the grate and shell is a good compromise.

All things considered, cast iron is the most suitable material for grate bars. The thin single bar *a* (Fig. 1) is the easiest form to handle, but is objectionable because it warps easily and renders the grate surface very uneven. It is better practice to cast the bars in nests of three, as in *b* (Fig. 1), which increases their resistance to warping sidewise, prevents the openings between nests from enlarging sufficiently to drop fuel into the ash-pit, and maintains a more satisfactory grate surface than can be expected with the single bars. The middle bar in a nest is usually made deeper than those on the outside.

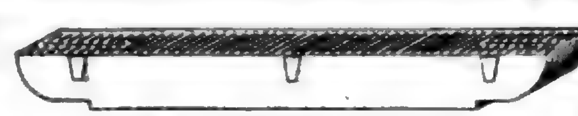


FIG. 2. SHEFFIELD GRATE.

The writer's experience has been that, with furnaces more than four feet deep, it is better to make the bars in two lengths, since those which run the full depth of the furnace are very heavy to handle, warp more easily than the shorter bars, and do not wear out evenly. The usual practice is to make the rear end of grates three or four

inches lower than the dead plate. No particular advantage is gained by doing this, while the bars are more apt to burn out near the bridge than when the grate is made level. It must be borne in mind that all cast-iron bars permanently elongate after being in service for a time; hence a clearance of one-half to three-fourths of an inch between the ends of the bars and the dead plate or bridge wall must be provided, when the bars are first put in place.

Experience seems to have demonstrated beyond a doubt that a total clear air-way between bars equal to twenty-five or thirty per cent. of the grate area is ample under all ordinary conditions, and much smaller areas have been used with excellent results. Some, however, advocate as much as forty-five or fifty per cent. of air-way, —an amount impossible to obtain with ordinary bars without providing between them spaces so wide as to permit a considerable quantity of fuel to drop through into the ash-pit. Such large air-ways can, however, be got by using a grate like the "Sheffield" (Fig. 2), or some of the herring-bone grates very similar to it. In these the short bars, or grids, can be made very thin with perfect safety, thereby enabling the increased air-way to be obtained.

Many forms of rocking, shaking, and dumping grates are offered in the market. Some of these, if under skilled management, are undoubtedly of value, but, considering them as a class, they are generally wasteful of fuel, and liable to get out of repair; hence the writer considers it only common prudence for the prospective purchaser to examine such grates in actual service with the kind of fuel he purposes to use, before deciding to employ them.

The bearers are also preferably made of cast iron. They should be as thin as possible, and the necessary strength should be obtained by increasing their depth. In furnaces five feet wide or more it is difficult to prevent the bearers from sagging under the heat, unless their depth is excessive. This trouble can be effectually overcome by screwing into the center of the bearer a leg, or support, made of 1¼-inch steam pipe.

Shallow ash-pits conduce to warping or burning out of the grate bars. Less than 18 inches between top of grate and bottom of ash-pit is bad practice; 24 to 26 inches is better. A greater depth holds out a temptation to let ashes accumulate, and defeats the very object for which it was provided. To cool the ashes and protect the grates the pit should contain several inches of water when the boiler is in operation. To provide for this, the pit bottom should be about six inches below line of ash-pit doors, level throughout, except where it slopes up to the doors, and constructed of a solid layer of concrete not less than six inches thick, made perfectly water-tight.

The bridge wall should be only high enough to mix the air and gases thoroughly and bring them into good contact with the shell. An opening over the wall equal to one-sixth the grate area is usually sufficient, but in no case is it advisable to make this area less than the total cross-section of the tubes, or to leave less than nine inches clear between the top of the wall and the lowest part of the shell. A smaller opening impedes the draft, concentrates the heat on too limited a portion of the shell, and increases the liability of burning the plates, if their inner surface becomes coated with scale.

The requirements for the space to the rear of the bridge wall vary according to the kind of fuel. With anthracite, combustion is practically completed in the furnace, so that, apart from convenience in cleaning, there is no necessity of making this space any greater than over the bridge itself. But with soft coals combustion cannot be completed in the furnace, and continues along the bottom of the boiler, and even into the tubes if the coal contain a high percentage of hydrocarbons. There will be less smoke and waste in proportion as the inflammable gases can be more thoroughly mixed with air, be kept from too close contact with the shell, which tends to cool the gases and extinguish the flame, and move at a relatively slow velocity until combustion has been completed. These results can be obtained in part by providing behind the bridge an open space, called the combustion chamber. A depth of 1½ to 2 feet below the grate level is sufficient for this space. Sometimes a depth of 6 to 7 feet is provided; this is overdoing the matter, and, besides, it increases the wall surface to be kept in repair, and augments the waste by radiation and leakage. A highly successful design, due to Mr. James I. Ayer, is shown in Fig. 3. In such constructions the height of the rear bridge wall should be determined in the manner already shown, while that just behind the grate is usually 3 to 4 inches lower. Fig. 4 shows the design advocated by the Hartford Steam Boiler Inspection and Insurance Company. This has proven satisfactory in service, is easier to clear than Ayer's arrangement, and I use it for anthracite and bituminous coals alike.

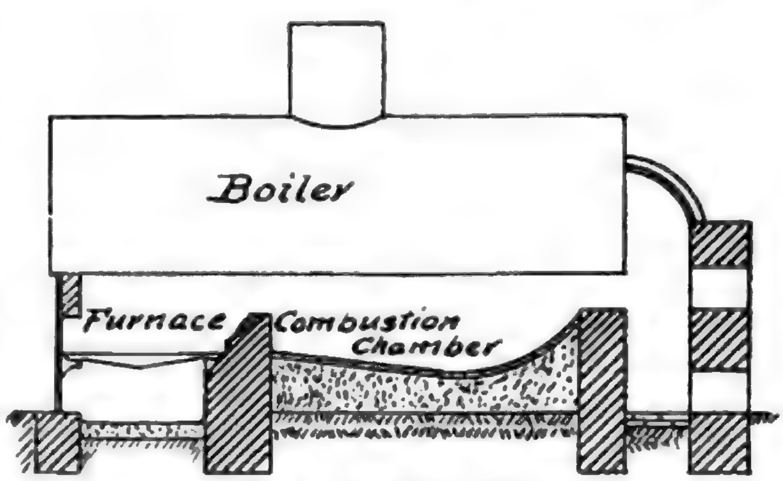


FIG. 3. AYER'S SETTING.

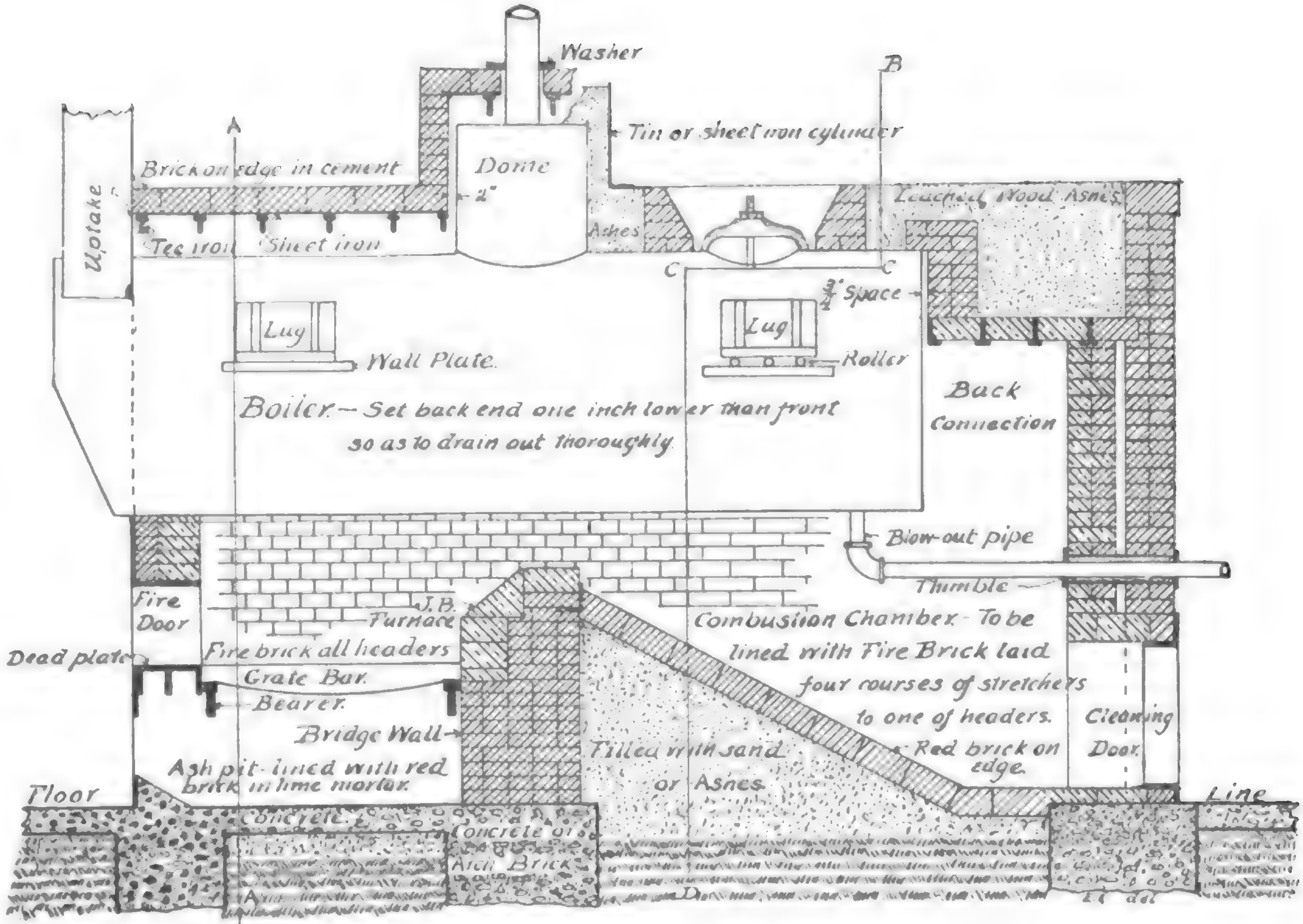


FIG. 4. LONGITUDINAL SECTION THROUGH SETTING. FOR TRANSVERSE SECTIONS SEE P. 595.

In the back connection the distance from tube sheet to rear wall of setting should be sufficient to enable a man to make repairs. It is difficult to swing a hammer in a space narrower than 28 inches; hence that dimension should be allowed, if circumstances will permit. The minimum area should be the same as that allowed for the uptake. An area not less than 10 per cent. in excess of that of the cross-section of the tubes should be allowed in the uptake, if it be fairly straight; otherwise, an excess of 25 per cent. is not too much. For sectional boilers this area may be taken at 1/6 that of the grate. In boilers with full flush fronts it is difficult to make a tight joint where the uptake connects wtth the setting; hence the overhanging front, in which the uptake is riveted directly upon the shell, should be selected.

At this point study of the constructive details should begin. Conditions essentially different from those governing ordinary masonry must be taken into account. Provision must be made for the entire structure to expand freely, without straining any part or causing fissures which may short-circuit the path of the gases, or permit infiltration of air. Perceptible settlement of any part of the structure must be guarded against, to insure an even distribution of the weight over the lugs or other supports. All parts subject to rapid deterioration must be capable of quick and cheap renewal.

A solid foundation is the first requisite, and excavation must be carried down until it is obtained. To guard against settlements the unit pressures on the foundation should be below the limit deemed consonant with safety in good building practice. Width of the wall footings is preferably such that the pressure per square foot will not exceed 4 to 5 tons on hard gravel and sand, 2 to 4 tons on hard, dry clay, dry, compact sand, or clay and sand, and 3/4 to 1 ton on wet clay or clay overlying quicksand. It is usual, however, to make the footings 8 to 12 inches wider than the superincumbent walls, except where they rest upon rock or hard, compact gravel. The liability of water leaking in under the foundation should be guarded against.

Where piling is not advisable, the most satisfactory method of dealing with very soft clay and quicksand is to place under the entire block plan of the boiler a sheet of well-rammed concrete, into which are embedded pieces of old rails laid at right angles to the axis of the boiler. From the footings up to the floor-level the walls should be built of good arch brick, and in the remaining portions only the best uniform-sized red and fire-brick should be employed.

The great range of temperature between the external wall and the furnace interior renders it practically impossible to keep tight any setting not built with separate inner and outer walls. The usual practice is to support the boiler by lugs resting on the inner walls. For

reasons presently to appear, the writer's custom is to carry the weight of the boiler and covering wholly on the outer walls, making them not less than thirteen inches thick, except in the rear of boiler. The inner walls are then reduced to a thickness of nine inches, and are so designed that they can be entirely torn out and replaced, without the necessity of blocking up the boiler and encroaching on the already cramped space available for making repairs. Further, not more than two lugs built into the brickwork should be placed on the side of a boiler; there is no difficulty in so designing these that two on a side are ample for any boiler not more than twenty feet long. A third one in the center is only a delusion. When firing begins, the bottom of the boiler expands more than the top; the two end lugs are raised from their seats, thereby frequently cracking the walls and always throwing the weight of the boiler and part of the masonry on the central lugs. Hence the latter are a source of danger rather than benefit.

The lugs should bear on a cast-iron plate about 1 foot long and 1½ inches thick, with reasonably plane surfaces to prevent the lugs from resting on one of their corners. Three one-inch rollers should be put between the rear lugs and their wall plates, and the latter are better if faced off true on top. It is useless to expect rollers to protect the wall from cracking, if the brickwork is laid up solid around the lugs in the usual way. The writer's custom is to leave a clearance of three-quarters of an inch between the masonry and sides of all lugs, and then form in the wall a pocket over which are placed some pieces of bar iron to support the upper wall. The space between the ribs of the lugs is then filled flush with masonry, and a piece of tin, built into the wall directly over the iron bars, extends out over the lugs, and prevents ashes, sand, or other filling from working down under the rollers (see Fig. 5). Each lug can then move in its pocket with perfect freedom.

Buckstaves should be put opposite the wall plates and along the other parts of the wall, at intervals not exceeding four feet.

The fire-brick lining is almost invariably bonded in with the red-brick walls, and is frequently stopped off several feet beyond the bridge wall. The writer believes it is true economy to line the entire inner walls with fire-brick; such procedure is imperative in many parts of the northwest, where the common brick rapidly crumble under even a moderate heat, if long continued.

Fire-clay has two serious defects; its cementing quality is slight, and it shrinks considerably in drying. Hence a wall built with it is naturally weak, and, if bonded in with red brick laid up in mortar, the fire-clay joints dry out more or less loose. Hence, when fire bricks in the furnace are laid mostly stretchers, the life of the lining

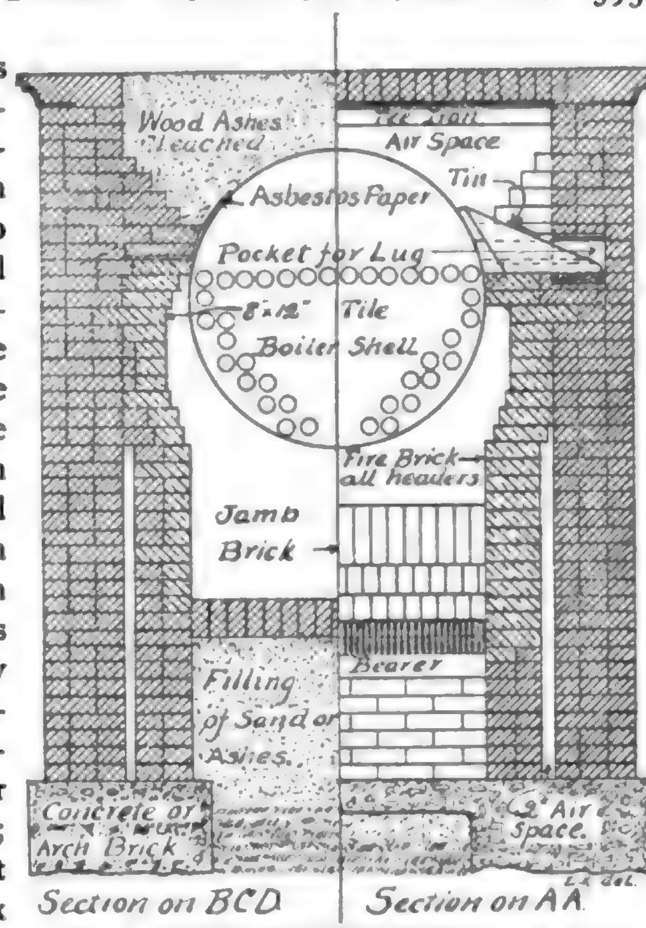


FIG. 5. SECTION THROUGH FIGURE 4, P. 592.

is short, because the shocks caused by detaching clinkers, and the gradual thinning of the wall through wear, cause the brick to fall out. The only method known to the writer whereby the shrinkage can be overcome is to use, in place of clay, a mixture of one part by weight of clay with three parts of pulverized fire-brick screened through a sieve with not less than forty meshes per inch. This combination shrinks very little. To increase the cementing qualities, slack into this mixture three per cent., by weight, of lime; this proportion has just sufficient action as a flux to fuse the whole together into a solid mass. It will increase the strength of the walls, and is particularly desirable when constructing fire-brick arches. The writer thinks that, even when this mixture is used, it will save money in the end to line the furnace up to 2 feet beyond the bridge wall with solid fire-brick laid all headers, with a 2-inch air-space between them and the outer wall, as shown in Figs. 4 and 5. Benezet or Savage fire-brick should be used for this lining, and neither here or elsewhere should any cut surface of the brick be exposed to the hot gases. The remaining parts of the inside wall may be built of a cheaper grade of fire-brick laid four courses of stretchers to one header and backed up with red brick. The walls should close in on the boiler at a point not higher than the bottom of the upper row of tubes. To provide the space necessary for cleaning, circulation of gases along shell, etc., the wall should be stepped back at the top, as in Fig. 5. Where rivets and edges of plates are met at the closing-in line, the bricks should be set back enough to let these pass during expansion of shell without catching on any part of the wall. The large tiles shown under the corbeling below the closing-in line are not absolutely necessary, but are advisable in order to support the upper part of the wall when the lower part is torn out. A lining thus constructed will last far longer than

the usual form, and the ease and rapidity with which it can be renewed are evident. Even the fire-brick ends from furnace headers can be used for repairing the rear walls.

Falling out of bricks from around the fire doors is an aggravating nuisance. To prevent this, the crown and jambs should each be formed of a solid piece of specially-moulded fire-brick ; else some efficient design of cast-iron frame must be employed. The common rectangular door casing, in which the jambs and crown are cast in one piece, will almost invariably sag in the center of the crown, and drop out the brick about it. Fig. 6 shows a design that the writer has used for six years with excellent results. The parts can expand independently, and up to the present not one of these cast-iron arches has shown signs of failure.

The top of bridge wall may be either an inverted arch, or flat. The former is more difficult to construct well and keep in repair ; hence it is rapidly dropping out of use. The latter form is especially preferable when ducts have to be built into the bridge to convey the extra supply of hot air necessary to consume the gases from coal having a large content of volatile matter. Even with a flat wall the erosion of the gases and occasional knocks from firing tools or logs of wood are liable to loosen the joints in the top course of brick. It is, therefore, good practice to cap the wall with 8×12-inch jamb tile on edge, bevelled off in front to facilitate cleaning. To prevent these from getting knocked out of place, an old bearer, or piece of angle iron, should be built in behind the wall, particularly where cordwood is used for fuel.

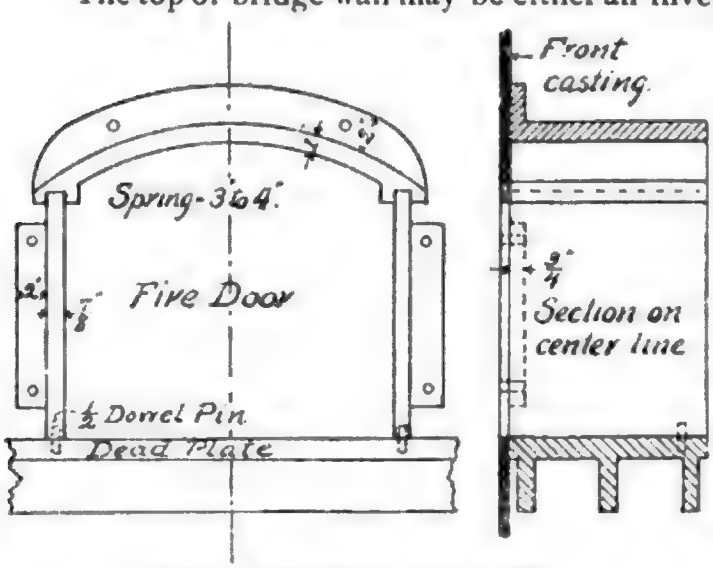


FIG. 6. FIRE DOOR AND CASING.

The back connection is preferably covered in by a flat roof about an inch above the top row of tubes. This form is easiest to repair, and gives more room inside for rolling leaky tubes, etc. It should be constructed of fire-brick laid between the stems of cast-iron T-bars, which extend clear through to the outer walls, so that they can support the roof when the interior walls are entirely torn out. No matter what form of roof be used, it must be stopped off at least three-

quarters of an inch from the tube sheet, to allow room for the boiler to expand, and be carried up to the exact contour of the top of the shell, so that the boiler covering can be carried over it.

The top of the boiler is usually protected by a filling of sand, or a brick arch turned over the shell. Both of these materials are objectionable, owing to their high conductivity for heat. Brick is further objectionable, because, when it rests upon the shell, it moves with the latter, thereby causing fissures between the arch and side wall, and roof over back connection. If a brick arch is wanted, it should have a layer of sand an inch thick between it and the shell, and a clearance of an inch should be left between the masonry and the dome, nozzles, etc., to be afterward filled in loosely with mineral wool or fire-clay. Better results can be got by using some of the specially-made boiler coverings, which are superior as heat insulators, and permit the shell to slide under them without causing breaks in the covering. Confined air is one of the very best insulators; hence an excellent plan is to span the entire space over the boiler with light T-iron, lay on this some sheet metal, and cover the whole with brick on edge in cement. An opening provided with proper cover must be left over the man-hole, and the necessary clearance around nozzle, etc., should be closed by a washer fitted around the pipe. If a dome is attached to the boiler, the brick work should be continued up around it and closed over the top as before, leaving everywhere an air space not less than two inches wide between the shell and inner face of the wall (see Figs. 4 and 5). Objections to this plan are the extra height of setting required and the difficulty of getting access to the top of the shell for inspection or repairs.

When wood fuel is used, a covering more satisfactory than any other which the writer has employed is obtained by carrying the walls up to eight inches above the highest point of the shell, and filling in the whole space level with thoroughly-leached wood ashes. On no account should unleached ashes be used, since serious corrosion will result if any moisture gets between the ashes and the shell. The high efficiency of this covering is apparent from the fact that, considered as heat insulators, the relative values of wood ashes, sand, and brick are as 61 to 17 to 7. A further point in its favor is the ease with which the shell can be uncovered at a trifling expense, and the same filling be put back again when the repairs, etc., are completed.

The nearly obsolete custom of carrying the waste gases over the top of the shell seems to be reviving. While this practice is not so objectionable in case of hot-water boilers, it should not be tolerated in any steam boiler, for reasons thus set forth by the Hartford Steam Boiler Inspection and Insurance Company. "If the setting becomes

shaken so that the side walls become separated even but a slight distance from the shell, then trouble begins, for the fire will take a short cut up the sides of the shell into the overhead flue, it being the most direct route to the chimney, and, in addition to destroying the efficiency of the boiler, the shell will always be burned, unless it is very soon attended to. With some waters also, even when the setting is in perfect order, there will be just enough heat passed over the top of the shell to cause the most astonishing amount of corrosion in the steam space, the writer having seen boilers running less than a year, with the shells eaten fully half way through by actual measurement, due to this cause alone; while in the same room, and running under exactly the same circumstances otherwise, with the exception that there was no flue over the top of the shell, were other boilers which had been running for fifteen or sixteen years, and were perfectly sound. Of this setting we can only say we see no advantage to be gained by adopting it, while there is a chance that serious damage may be done." Further, any possible small efficiency gained at the start is usually soon lost by accumulations of ashes and soot on the shell where it forms the bottom of the flue.

Pipes passing through the side walls should be avoided, if possible. The feed is preferably taken in at the top or front, and, where the blow-out pipe or returns from heating systems pierce the rear walls, they should pass through a thimble of larger pipe built solid into the wall. The annular space between the two should be packed with mineral wool, or asbestos fiber, and be stopped off at each end with a washer secured to the thimble. Mud drums should be so placed that their axis is parallel to the axis of the boiler. If set at right angles to boiler, with ends projecting through the side walls, the expansion of the boiler must necessarily crack the brick work around the drum, and greatly increase the air leakage. Badly-fitting cleaning doors are also sources of large air leakage. These doors should be ground to a close fit, or be provided with asbestos washers and a strong clamp handle, so that they can be drawn up tight. If exposed to strong heat, they should be provided with an inner baffle plate, or a lining of fire-brick, to prevent warping. Doors into the front and uptake should also be ground to a good fit.

Every precaution must be taken to prevent water from leaking into the setting. Escapes from safety-valves should be piped off beyond the setting walls, and liability of leaks from defective pipe joints—flanged joints in particular—should be guarded against.

The highest grade of masonry is essential, if the setting is to be durable. If the design herein advocated is adopted, the entire outer walls are preferably laid up in cement. In any case cement should be

used for all parts below the floor line, and the last foot of height of the outside walls. Lime mortar should be allowed to sour at least three weeks before working up, or it will crumble under action of the heat. Thin joints are imperative. Those between the red brick should not exceed five-sixteenths of an inch. Satisfactory results can be expected from fire-clay only when it is thin enough to be poured with a cup; each brick must be rubbed into place and firmly driven down with a mallet, until it bears on the one below, leaving between them only sufficient clay to fill the interstices due to irregularities of the brick.

The ruling custom is to block the boiler in place, and then erect the masonry around it. An objection to this plan is that a man can do neither the quantity or quality of work that would be possible in less cramped working quarters. The writer has, therefore, found that, when sufficient head-room is available, it is advantageous to lay down a complete detail-drawing of the entire setting, construct the masonry up to the level of the lugs, allow the walls to dry, and then move the boiler into its final position. The increased expense of handling the boiler is usually more than made up by the saving in bricklayers' time and the superior quality of masonry obtained.

No matter how well the walls are built, it will be difficult to keep them tight and make extensive repairs cheaply when the weight of boiler and covering rests upon the masonry. The practice of hanging shell boilers on steel frames independent of the masonry, in accord with standard practice in setting water-tube boilers, is, therefore, on the increase. It saves considerable masonry and space, makes a much neater construction, and dispenses with buckstaves.

Accessibility of all parts is essential to efficient operation, and to prompt action in times of danger. Ample room should be provided in front of boilers for handling fuel and ashes, and for working a tube-scraper. The clear space between the rear wall of the setting and the side of the building should be such as to afford ready access to cleaning doors, space in which to do pipe-fitting, etc., and in a large plant there should be two passages connecting this rear space with that in front of the boiler.

In the average steam plant the boiler is even yet the last member to receive adequate attention in regard to such small details as have been discussed. Too frequently the setting is left to men whose only qualification is their ability to lay brick and willingness to accept low wages. No successful plan has yet been evolved whereby it is possible to obtain something from nothing, while those who wisely expend at the start the money and brains necessary to secure efficient and durable construction find that, during the life of the plant, their investment is returned to them many fold.

THE BUSIEST CANAL IN THE WORLD.

By Wm. P. Kibbee.

THE chain of great lakes in which the two peninsulas of Michigan are situated covers an area of 90,300 square miles, and constitutes more than one half of the fresh waters of the globe. With the exception of Ontario, the borders of Michigan are washed by the waters of all these lakes, five in number, which, by their depth, magnitude, and extent, give her an advantage that no other inland State can hope to enjoy. At its southeastern extremity the State is touched by the waters of Lake Erie, a body of fresh water two hundred and twenty miles in length and forty-eight in width, and with a maximum depth of about two hundred and four feet. Its height above tide-water is about five hundred and sixty-four feet. Connected with this by the Detroit river is Lake St. Clair, a shallow body of water, eighteen miles in length by twenty-two in breadth, and having a depth of twenty-four feet, and an elevation of five hundred and seventy feet above the ocean. Thence, by a second strait, the St. Clair river, we pass to the north upon the bosom of the Lake of the Hurons,—a lake which abounds in the finest of trout, and is seldom, according to the traditions of the Indians, visited by severe storms. Lake Huron, which forms the eastern boundary of Michigan, separating it from the province of Ontario, is two hundred and fifty miles long, with an average breadth of about one hundred miles, a depth of about nine hundred feet, and a height above tide-water of five hundred and seventy-four feet. Its superficial area is about 20,400 square miles. Connected with this by the straits of Mackinaw, which separate the two peninsulas, and extending southward nearly parallel with it, and thus forming the entire western boundary of the lower peninsula, is Lake Michigan. This great body of water is three hundred and twenty miles in length, eighty in width, and eight hundred and forty feet in depth, and its surface lies five hundred and eighty-seven feet above tide-water. It has a superficial area of 22,400 square miles. Green Bay, an arm of Lake Michigan, so important to the shipping interests of the northwest, is one hundred miles in length and twenty in breadth, with sufficient depth for navigation. If, instead of passing westward through the beautiful straits of Mackinaw into Lake Michigan, we continue northward from Lake Huron through the Hay Lake channel and between the shores of the St. Marie, avoiding the Sault by availing ourselves of the magnificent locks which the government has finally completed, we enter upon the surface of the southwestern

extremity of "Gitchigamme"—Lake Superior. This, the greatest body of fresh water found upon the earth, is three hundred and fifty miles in length, one hundred in breadth, eight hundred and seventy-eight feet in depth, and six hundred and twenty-seven feet above tide-water. It covers not less than 100,000 square miles of surface. This immense shore line, and the numerous streams emptying into it, have been the greatest means of settlement in the northwest, by rendering all parts of it so accessible. The immense forests of pine, otherwise unavailable, are, through this magnificent water-communication, readily attacked; the logs in vast quantities are floated down the streams to the mills at the mouth of the great rivers on the lake shore, where they are cut into lumber, which is loaded into vessels and transported to different ports.

THE RAPIDS OF THE ST. MARY'S RIVER.

The ores of the northern peninsula of Michigan, of which so great a quantity is now annually mined and shipped away, would be of little or no value, were this chain of navigable waters to be removed.

The broad, deep bodies of water lying upon either side of the lower peninsula are the great modifiers of its temperature. They are reservoirs of the summer's heat, which is slowly given up again during the cold season, tempering the bitter blasts and depriving them of their killing power.

THE EXIT FROM THE NEW AMERICAN LOCK.

The terrible storms from the northwest that sweep over the open waters of Lake Michigan mingle with the vapor ever rising from its bosom, and, thus modified, they reach the borders of Michigan no longer endowed with the power to destroy. From this cause the western border of Michigan has become known as the fruit-belt, a region where many of the choicest fruits are largely and profitably cultivated.

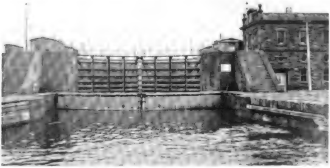
The upper peninsula of Michigan, made famous for the quality and extent of its minerals, is for the most part mountainous, though presenting a kind of scenery peculiarly magnificent. The outlying country of lower Michigan may be described as swelling into gentle

THE UPPER END OF THE AMERICAN CANAL.

hills and undulations, covered with forests of heavy timber, or groves of oak, which seem like natural parks, or expanding into rich prairies or crystal lakes.

The first settlement in Michigan was made by the French at Sault St. Marie, in 1608, and from a mere trading-post in those days it has become one of the most conspicuous points in the great avenues of commerce between the great lakes, and nucleus of the grand procession of stately steam and sailing craft to and from the northwest.

The city of Sault St. Marie offers much of historic interest. It is built on a level, and immediately alongside the government locks and canal. Fort Brady, the government's strong-hold at this point, occupies a commanding position on a hill overlooking the city and canal, while running through the city proper is a water-power canal, two miles long, that for some reason failed of its purpose. The population is about five thousand, mostly whites, and the few Indians that are left earn a livelihood by hunting and fishing.



LOWER APPROACH TO THE CANADIAN LOCK.

Directly across the lake stands the Canadian Sault, where is situated the new lock built by the Canadian government at a cost of $4,000,000. The two towns, with their environs, are usually comprehended under the one name of Sault St. Marie.

In the early days, when the fur trade was the predominating industry in the region of the great lakes, the Sault, as well as the island of Mackinaw, were the most important stations of the Hudson bay and American fur companies. On the annual return of the fleets, and the assembling of the Indians for traffic, this rendezvous became a scene of great animation; the transparent waters were dotted with canoes and *bateaux*, merchants, traders, *voyageurs*, and gaily-bedecked savages, coming from every quarter.

Originally, the only means of access to Lake Superior was over the rapids, which were so shallow and rocky as to admit of no craft drawing more than two feet of water, and even such craft found shooting these foaming billows very dangerous.

When the great copper and iron mines were discovered on Lake Superior, it soon became evident that a lake communication with the east was all that was lacking to rank these mines among the greatest producers of their respective ores in the world.

To obtain a continuous route to the lower lakes it was necessary to build a canal, lock, and channel, reaching from the southern extremity of Lake Superior to the north shore of Lake Huron.

Lake Superior being twenty feet higher, mean level, than the lower lakes, it was necessary to construct a lock, by which vessels might be raised or lowered to a position corresponding with the levels of Lakes Superior and Huron, by way of the Hay Lake channel and Mud Lake, or of Little Lake George, as the case might be.

STEAMER NORTH WEST ENTERING THE AMERICAN LOCK.

By an act approved August 26, 1852, congress granted to the State of Michigan 750,000 acres of land, to be used to pay for the construction of a ship-canal around St. Mary's falls. The State legislature accepted the grant, and authorized the governor to appoint commissioners to contract for the work and to enter the lands authorized by the grant. In consideration of becoming possessed of the entire body of lands donated for the purpose by the State, the work of constructing the canal was undertaken by a number of eastern capitalists, and the first ground was broken on June 4, 1853. Its prosecution was attended with considerable difficulty; but the canal was finally completed and opened to the public in June, 1855,—two years from the date at which the work was begun.

COPPER-LADEN VESSELS PASSING THROUGH THE AMERICAN LOCKS.

It soon proved inadequate to the wants of commerce, and its enlargement was undertaken by the general government, and carried on through many years, until its completion. Commerce and civilization have long since spread over the entire northwest. The paddle of the savage is supplanted by the powerful wheel of the steamship, and the *bateau* of the *voyageurs*, which bore away the fur of the beaver, is displaced by innumerable vessels loaded with the products of the farm, the lumber-camp, and the mine ; but Sault St. Marie retains much of the importance which it held two centuries ago. It must not be understood that the multitude of steam and sailing vessels really center there. They are passing up and down continuously, and with a regularity that

EIGHTEEN-HOURS' BLOCKADE IN THE SAULT CANAL, ON ACCOUNT OF DAMAGE TO THE LOCK.

is amazing,—about sixty-five vessels of all kinds each day, on an average. The writer witnessed in 1890, when the gates refused to open, a procession of stately craft three miles long waiting to be locked through. The following figures give some conception of the business handled at this canal. Number of vessels locked through during the fiscal year 1895, 17,956. Registered tonnage, 16,806,781 tons.

Total amount of freight, 15,062,580 tons; valued as follows:

Coal (hard and soft)	$ 6,993,351
Flour	33,383.632
Wheat	30,041,863
Grain other than wheat	4,164,347
Manufactured iron	3,683,150
Pig iron	346,788
Salt	202,439
Copper	21,490,400
Iron ore	22,332,319
Lumber	8,888,400
Silver ore and bullion	11,200
Building stone	238,760
Unclassified freight	27,798,480
Total	$159,575,129

The new lock, which was opened a little less than a year ago, and is considered the finest piece of canal engineering on the great chain of lakes, has a clear length between gates of eight hundred feet, and a width of one hundred feet. When the water is at its normal stage, vessels drawing twenty-one feet of water can pass through with well-ordered safety. The walls on each side of the new lock are 1,100 feet long, while from the east end, for 282 feet, the walls are 45 feet high.

THE FORMAL OPENING OF THE NEW LOCK.

INTERIOR OF THE NEW AMERICAN LOCK.

and from that point westward 43 feet high. At the base the walls are 20 feet wide, this width continuing for 10 feet, when, by five 2-foot offsets, 5 feet apart, they gradually narrow to 10 feet in width. At both upper and lower ends the walls are 36 feet wide from base to summit. The walls are faced with the best Kelly Island limestone, which was transported to the Sault in the rough. The facing of the lock wall consists of twenty-three courses,—*viz.*, courses two to twenty-two, having stones 6 feet long, 3 feet wide, and 2 feet thick; part of the initial course; and the coping course, being 1½ feet thick. The cost to the United States for the masonry alone was $1,085,469.

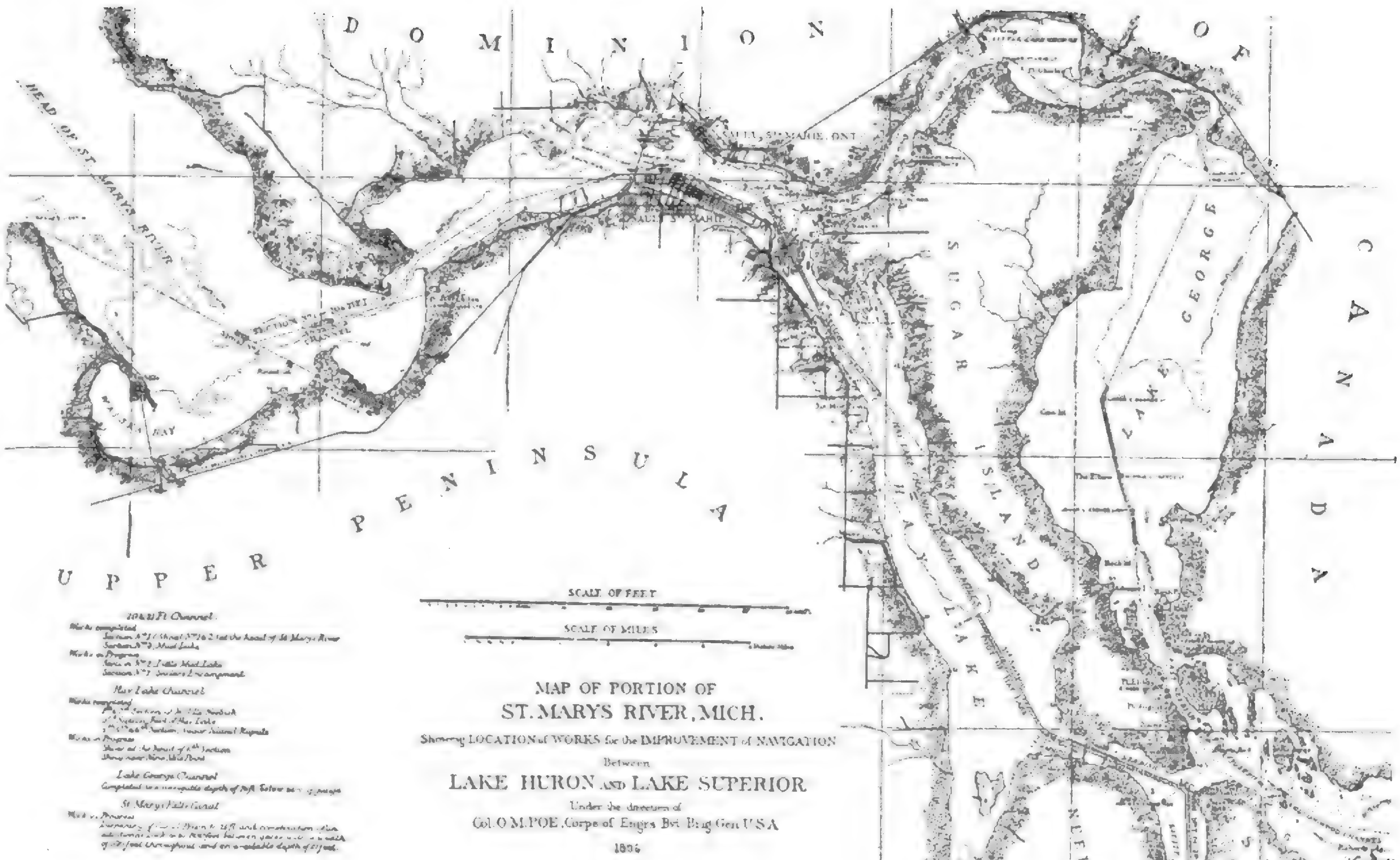
The new lock is equipped with five gates, constructed wholly of steel, which were put to the severest test before acceptance. They are known as the upper guard, upper lock, intermediate lock, lower lock, and lower guard gates. In dimensions the upper guard and upper lock gates are 26 feet 6 inches in height; the lower and intermediate gates are 43 feet high; and the lower guard gate is 25 feet 6 inches from base to top. All the gates are uniform in length,—55 feet,—and are the largest steel gates in the world. Each leaf of the smaller gates weighs in the neighborhood of 100 tons, while those of the larger ones weigh 190 tons respectively. Each leaf is supplied with two air-pumps and air-chambers, stationed at a point near the base of the gates, while the two water-chambers occupy a position above the center. To retain the equilibrium of the gates and to conquer superfluous strain upon the quoin posts, these air- and water-chambers are used in conjunction very advantageously. The air-pumps are operated by human power from the tops of the gates. The cost of the gates, with the anchorages, was $203,000, and they were built in Detroit, Mich.

PASSENGER STEAMERS BEING LOWERED INTO THE ST. MARY'S RIVER.

The immediate machinery of the lock is divided into two separate and distinct plants,—the operating plant and the pumping plant. The former consists of six machines that operate the gates. Twelve engines open and close the valves, by means of which the chambers are filled and emptied, and two hydraulic capstans, with the pumps, accumulators and piping, complete the lock operation.

There are two capstans, one at either end of the lock on the south side. In appearance they are similar to the ordinary naval capstan. These capstans are driven by three single-acting, oscillating, hydraulic engines, each of which is designed to develop a pulling-power of 19,000 pounds. The capstans are for use in assisting vessels through the lock when not provided with power of their own.

THE CANADIAN LOCK, SAULT ST. MARIE, ONTARIO.


DOMINION OF CANADA
UPPER PENINSULA
HEAD OF ST. MARYS RIVER
SAULT STE MARIE, ONT.
SUGAR ISLAND
LAKE GEORGE
HAY LAKE
SCALE OF FEET
SCALE OF MILES
MAP OF PORTION OF
ST. MARYS RIVER, MICH.
Showing LOCATION of WORKS for the IMPROVEMENT of NAVIGATION
Between
LAKE HURON AND LAKE SUPERIOR
Under the direction of
Col. O. M. POE, Corps of Engrs Bvt. Brig. Gen. U.S.A.
1886
Hay Lake Channel
Lake George Channel
St. Marys Falls Canal

The operating machinery was designed in the United States engineer's office at Detroit, and cost $60,000. The gate machinery differs entirely from any at present in use, in that it represents a combination of hoisting machinery and highest English hydraulic practice. The pumping machinery, whose sole duty is emptying the lock in case of accident to the gates, is placed in the basement of the power house, and consists of three centrifugal pumps, each having a discharge of thirty inches in diameter. The driving-power consists of three Westinghouse engines of 350 h. p. each. The steam is furnished by a battery of water-tube boilers, set in steel cases. The machinery, which was designed by J. Kennedy, of Pittsburg, is said to be capable of emptying the lock in seven hours.

The lock chamber can be filled and emptied in seven minutes. The water is let into the lock through six culverts, which run longitudinally below the lock floor.

The office and power-house are built of cut stone, and alone represent an outlay to the government of $100,000. The whole work completed will cost the government $5,000,000.

Work on the new lock was commenced in May, 1887. The lock was formally opened to traffic August 3, 1896, when the river and harbor boats, the Hancock, of Detroit, and the revenue cutter, Andy Johnson, passed through. The opening was suitably observed by the salute of one hundred and twenty-six boats, which were in port, and continuous whistling was kept up for fifteen minutes.

Average time occupied in making a lockage, 40 minutes.

Cost per lockage, $7.89.

Cost per passage, $3.34.

The new canal and locks built by the Canadian government, and which were opened to the craft of any nation flying a peaceful flag, went into commission shortly before the American locks were opened. The Canadian locks are directly opposite the American Sault, and have an advantage that any person versed in naval affairs may readily understand. Prior to the completion of this canal, all Canadian craft doing business along the shores of Lake Superior were compelled to pass through the American Sault. The completion of the canal enables them to pass to and from Lake Superior through a waterway exclusively Canadian. I shall not touch upon the design or construction of this lock, other than to say that it is built after the plan of the American locks, and is perfection.

Much trouble, however, was experienced early in the work by a series of cave-ins of the masonry. This has now been remedied, and the lock is as substantial a structure as could be wished for. The cost of this work to the Canadian government was about $4,000,000.

REVIEW OF THE ENGINEERING PRESS

American Ship-Building and Shipping.

THE views of one of the most famous ship-builders in the United States upon the present status of American ship-building and shipping, cannot fail to be interesting, though we need not at all adopt his point of view nor accept his conclusions as to policy. The interest is heightened when his views and principles are contrasted with the clear and vigorous paper by Capt. John Codman, which appears in the leading pages of this issue. Charles H. Cramp, in a paper read before the senate committee on commerce (April 7), and reported in *Iron Age* (April 15), maintains that "no nation can either build or own ships, when, unprotected and unencouraged, it is brought in competition with other nations that are protected and encouraged." He asserts "that the enormous revenue represented by the freight and passenger tolls on our commerce and travel is constantly drained out of this country into British, German, and French pockets, in the order named, but mainly British; while the vast industrial increments represented by the necessary ship-building inure almost wholly to Great Britain. For this drain there is no recompense. It is sheer loss. It is the principal cause of our existing financial condition. So long as this drain continues, no tariff and no monetary policy can restore the national prosperity. Until we make some provision to keep at home some part at least of the three hundred and odd millions annually sucked out of this country by foreign ship-owners and ship-builders, no other legislation can bring good times back again. It is a constant stream of gold always flowing out." The author argues that the United States is, by the folly of its own people, reduced to a state of financial and industrial subjugation to England. "Great Britain has many out-lying colonies and dependencies. The greatest two are India and the United States. She holds India by force of arms, whereby her control of that country costs her something. She has to pay something for her financial and commercial drainage of India. She holds the United States by the folly of its own people, whereby her control of this country costs her nothing. . . . The amount of her annual drainage of gold from the United States far exceeds that from India. Therefore, the United States is by far the most valuable of all the dependencies of Great Britain. In the relation of England to India there is something pitiable, because India is helpless. In the relation of the United States to England there is nothing that is not contemptible, because it is the willing servitude of a nation that could help herself if she would." Figures are given by Mr. Cramp to indicate the enormous efforts that England is making to conserve her supremacy of the seas. "England, clearly seeing that, in this age more than ever before, ocean empire is world empire, strains every nerve to perpetuate her sea power, and exhausts her resources to doubly rivet the fetters which it fastens upon mankind. Since 1885 England has expended $517,000,000 for new ships of war and their armament. During eleven years she has built 38 first-class battle-ships, 3 second-class battle-ships, 9 armored cruisers, 20 first-class cruisers, 51 second-class cruisers, 33 third-class cruisers, 30 gunboats, 12 composite sloops, and 74 torpedo-destroyers, including the vessels authorized in the current year's programme. The aggregate is 270 vessels of 1,136,575 tons' total displacement, 1,674,700 h. p. Of the navy England already had in 1885 there remained available 42 armored ships, 34 cruisers, 11 sloops, 19 gunboats, and 95 torpedo boats, which she is re-engining, re-arming, and otherwise modernizing as rapidly as she can. In *personnel* afloat she has augmented her force from 52,600 in 1885 to 100,500 in the estimates for 1897. In other words, England has doubled her navy in *personnel* and material, and more than quadrupled

it in war-like efficiency, during eleven years of the profoundest peace the world ever saw." Mr. Cramp shows that England has, in 1896, made a practical addition of 1,370,000 tons to her merchant marine. He attributes this effort on the part of England to the alarm induced by the efforts of Germany to increase her naval power, and the additions which the United States have recently made to their naval force. He states with great positiveness that England "has determined that she shall be not only the supreme sea power, but also that, except within limits set by herself, there shall be no other sea power at all. . . . The moment any other national aspiration towards sea power reaches the point at which it begins to affect her naval supremacy or dispute the ocean monopoly of her merchant marine . . . England will crush it by intrigue, by cajolery, by treaties, if she can. She will crush it by preponderating force, if she must." It is charged that England has dealt with the utmost unfairness with the two first-class American ships put in the trans-Atlantic trade under American management. "Every resource that unscrupulous rivalry can suggest has been exhausted by the English press and the English administration to defame and discredit them. English officials abroad, from ministers and consuls down, industriously reproduce in the newspapers of Japan, China, Chili, Argentine, and Brazil the misstatements of the English press about American vessels. The British post-office delays the American mail for days in the slower ships of the Cunard line rather than send so much as one letter by the American line. Our post-office responds by liberal allotments of its European mail to all the British lines. The result of all this is that, while this country has never known such industrial stagnation and such financial distress, England has never known such industrial activity or financial prosperity as now."

Congressional Regulation of Railway Traffic.

On general principles we do not attach great importance to the views of secluded professional men upon the practical questions of active business. By "secluded" men we mean men who, like professors in collegiate institutions, are mostly shut out from participation in the active affairs of business, and who, from the very nature of their occupations, are brought into contact chiefly with theoretical principles apart from the limitations and restrictions which practical men encounter in the application of theory to human affairs. This is not said in derogation of theoretical principles or the men who devote their lives to their study. The latter are among the most useful of mankind; for it is entirely certain, notwithstanding what we have said above, that successful practice cannot cut loose from sound theory, and that the latter must be regarded in obtaining a proper comprehension of its practical limitations, to say nothing of the application of the knowledge thus gained to practical affairs. For this reason we are not surprised that the paper read by Prof. Howard S. Abbott, of the University of Minnesota, before the national convention of railroad commissioners,at St. Louis (May 11), fell, apparently, rather flat, notwithstanding its literary and historical value. The paper, reported in *The Railroad Gazette* (May 21), is valuable historically as a review of legislative action upon the subject in the United States since the foundation of the republic, and probably most students of economics will agree with the author upon the general proposition that "the causes producing unjust discrimination will be found to consist of economic laws and conditions and the selfishness of human nature." But how is legislation to intervene successfully between these antagonistic forces? This is a question upon which the widest differences of opinion may and do exist, not only among theoretical, but among practical, railroad men, and particularly between these two classes of thinkers, the former class being apt to underrate practical obstacles to the practice of theory, and the latter being wont to exaggerate practical difficulties, while taking a too narrow view of theoretical principles. Thus the *Railway Age* (May 14) sarcastically calls the railway bill recently passed

passed in Florida "the law to discourage railway investment in the State of Florida"; and, in speaking of Prof. Abbott's thesis, it says: "It is hardly probable that the address convinced a single railroad commissioner that his powers and emoluments ought to be dispensed with, and that the supervision of the railways ought to be turned over to a national board." As a matter of fact, though the address was courteously listened to, and ordered to be printed in the proceedings, any endorsement of Prof. Abbott's views was expressly disclaimed by the convention. The paper, however, may be profitably studied by all who wish to be thoroughly informed upon the history of court decisions, relating to governmental powers over commerce, upon existing incongruities, and upon the difficulties arising from independent regulation by States."

Competitions in Architectural Designing.

A NUMBER of the most reputable architects in New York have initiated a movement that should have been started at an earlier date, since the evils it is designed to correct have long been felt as a burden and have been many times pressed upon the attention of the profession and of the public. The movement is in the nature of a mutual agreement, which, already signed by a considerable number of leading architects, is, as we understand, to remain open for the signatures of all practising architects who favor its provisions. The agreement has for its object the stipulation of conditions under which reputable architects will compete with each other, and supply designs for such competitions. It is evidently hoped that this movement will tend to the diminution of the number of invitations to compete under conditions with which architects of good standing cannot comply. The stipulations in this agreement, to which the signers pledge themselves to adhere, provide for reimbursement of the cash outlay in preparing drawings for competition; for the naming of a definite number of competitors, not to be increased or diminished except by consent of the competing architects; for the payment of the standard fees for professional services (established by the American Institute of Architects) to the successful competitor; for the services of a professional adviser in arranging the programme of competition; for a general consultation, with those invited to compete, upon the subject of the programme; for the exclusion of all competitors who do not comply in all particulars with the requirements of the programme; that no additional drawings shall be demanded, or any new competition shall be instituted; and that the designs submitted shall be signed and, if desired, explained, by their authors. We have not thought it necessary to quote the precise language of the agreement in which these stipulations are couched; those desiring the full text may find it in the files of any of the American Architectural publications (*Architecture and Building*, Vol. XXVI., No. 20, contains it). Undoubtedly it is a movement in the right direction, well calculated to reform existing methods and to promote fairness in the conduct of competitions.

State Roads of Massachusetts.

MASSACHUSETTS, by legislation establishing a permanent highway commission, and by an appropriation of $300,000 for the construction of new roads and the reconstruction of old roads, has, as pointed out by Mr. Albert A. Pope, in *The State's Duty* for May, set the pace for the general improvement of highways throughout the United States. He says: "As a natural result of the popular agitation and the monster petition which I had the honor to present to congress in 1893, the United States recognized the necessity of a move in this direction, and, under 'the agricultural bill,' made a special appropriation of $10,000 to meet the expense of a careful investigation into the condition of roads throughout the country, and for the publication of such information as would assist the people in bettering their highways. The department of agriculture has issued a number of bulletins, and it is gratifying to learn that more than a score of States have already passed new road laws, while nearly all the others are planning for the adoption of measures for the promotion of

this reform. Experience has shown that the course pursued by Massachusetts is the one which commends itself most strongly both to the people at large and to their legal representatives, the various State legislatures, and it is natural to suppose that, if all were familiar with the work here, the knowledge would be utilized to bring about similar legislation wherever the method of procedure is still unsettled." In June, 1892, a temporary commission was appointed by the legislature of Massachussetts for investigating the condition of the public roads, and to draft a bill for their improvement. A law suggested by this commission passed in June, 1893. An act passed in June, 1894, not only increased the powers of the State commission, but permitted selectmen of any town, or the mayor and aldermen of any city, as well as county commissioners, to petition the highway commission for taking roads as State highways. The highway commission was also empowered to use the appropriation ($300,000), without further legislation, in building State highways. The commission, in accordance with its increased powers, has expended the money pretty evenly in fifteen counties. The apportionment of the money was based upon the facts of each case as determined by personal and official observation on the spot. The policy of expending the appropriations upon small sections of roads widely distributed was adopted on account of its educational value, each section being "an object-lesson to those living nearby." The report of the Massachusetts highway commission (January, 1895) is recommended for consultation to those who are considering legislation. A large amount of general information is compressed into Mr. Pope's article. A significant fact is that, where it has been found expedient to widen roads for the accommodation of increased traffic, the town officials, on account of the obvious advantages to owners whose property meets the highways, have been able, for the most part, to obtain the necessary releases without cost. Mr. Pope says that "thirty-eight sections have been contracted for, and only eight of them are to have a width of eighteen feet of hardened surface, all others being fifteen feet wide. As the primary object is to get length of way, the commissioners are considering the advisability of building single-track roads in the thinly-settled districts. These would not be over nine feet wide, with here and there portions of double width as convenient passing points for carriages. A mile and a half of such roads can be built for less than the cost of a mile of fifteen feet wide, and the advantage in getting produce to market is not lessened, provided such construction is confined to localities where the average traffic is from six to eight vehicles per hour. There is need of legislation to regulate the care of, and responsibility for, sidewalks on State highways. These, being of purely local advantage, should be under the supervision of the town, the wheelways alone being constructed and kept in order by the State. The laboratory work on road-building stones, in Lawrence Scientific School at Harvard University, is commended. An important feature of this work is a series of maps showing the situation of deposits of stone suitable for road-making, thus enabling the commission to obtain its supplies from the nearest available locality.

The Crucible as a Metallurgical Implement.

THE different kinds of crucibles in use for metallurgical operations are not many, for the simple reason, that many materials more refractory than the metals to be fused, and capable of being formed into pots for melting these metals, do not exist. Certain qualities of sand, clays, and graphite,—popularly called plumbago, or black-lead,—are practically the principal materials from which melting-pots are made. A brief account of the crucibles used for various purposes in the arts, with more extended remarks upon their manufacture and their care in use, are given by Mr. John A. Walker, in *The Iron Age* (May 20). For laboratory use the smaller crucibles of platinum, porcelain, Hessian sand, and plumbago are used, these being substantially the same, except in size, as those for more extensive industrial use. "Straight-out clay crucibles," Mr. Walker tells us, are still used in metallurgy; but,

"while English steel-makers still cling to the use of the one-heat clay crucible, the vast bulk of all the metals and alloys are fused in the modern graphite crucible." The Hessian sand crucible is also still used more or less by assayers. The manufacture of the graphite crucible is said to be confined to six countries,—to wit, France, Germany, England, Japan, China, and America. The reasons for the more extensive use of graphite crucibles, as compared with crucibles of other kinds, are their more ready conduction of heat, which reduces the time required for fusion of their contents, their greater durability, resulting from their greater refractoriness and their superior strength and elasticity. This comparison of qualities applies to all other kinds of crucibles, except those of platinum, whose cost, however, precludes their use except for laboratory purposes; and platinum is even less refractory than graphite. The strength and durability of platinum crucibles, could these qualities be secured in an otherwise practical material costing no more than, and at the same time as refractory as, graphite, would render such a material an ideal one for the purpose. Few are aware of the care required for the successful manufacture of graphite crucibles. It is with this as with many other seemingly simple industrial processes whose very simplicity exacts the exercise of judgment and skill to a greater degree than other more complicated operations wherein the inherent qualities of the materials do not play so important a part. Mr. Walker says that the successful maker of graphite crucibles "must make constant chemical analyses of his materials, and he cannot have too much knowledge of the broad lines practised by his customers. The fusion points of different materials are vastly dissimilar. This must be taken seriously into account. For instance, the crucible made for steel-melting is useless in a brass foundry. It is far more refractory, it is true, but, if the brass-melter employed a crucible intended for steel-melting, it would slowly wither away in his lower temperature, whereas it would behave beautifully in a furnace at a temperature of 1,000° F. higher." This would seem to imply that high temperature is not the only disintegrating force in the destruction of a crucible. Mr. Walker gives no explanation of this alleged fact, which, we venture to say, will be new to the majority of readers, and it would have been interesting to know more precisely what there is in a brass furnace that will destroy a crucible of a given composition more quickly than a steel furnace at a temperature 1,000° higher. It may be that the explanation is implied in a succeeding paragraph, which treats of the effect of fluxes upon the binding materials of crucibles, but this is not explicitly stated. Summing up the "causes of unreasonably short life in crucibles," these are brought under three categories,—to wit., the want of adaptation of crucibles to the particular service in which they are to be employed, rough usage (often unavoidable), and "corrosive fluxes." "The crucible maker does not know what the melter will use; the melter does not always know the destructive influence of his flux on the walls of his particular melting-pot." It seems, therefore, advisable, that a mutual understanding between the manufacturer of crucibles and his customers upon the matter of fluxes should be sought, since it is implied that by a variation in the binding materials this destructive action could often be resisted.

The Uses of Exhaust Steam.

EXHAUST steam can be utilized in various ways. Condensed and separated from oily matters, it becomes a comparatively pure material for the manufacture of artificial ice. The purest ice to be obtained in our city markets is made of water condensed from exhaust steam. Water so condensed and separated from oily matter is also the best obtainable for boiler feed. The use of surface-condensers not only effects an economy of fuel, but supplies pure water for steam boilers in situations where the water is of such quality as otherwise not to permit its use for generating steam. Another use for exhaust steam is for heating buildings. On this use, Mr. Willard Hatch (*Iron Age*, May 6) has made some instructive observations,

which will be of use to those contemplating such an application. He assumes a building of definite proportions, using a given amount of steam power, and then considers the value of the exhaust steam for the two purposes of producing an increase of power by the use of a condenser, and the simultaneous heating of buildings, both of which applications may be made together during a considerable part of the year, in climates wherein the artificial heating of buildings is required. What the author calls incident heat in buildings—*i. e.*, heat developed mechanically, that derived from the persons of workmen, and that derived from gas jets—is shown to be an important factor in warming factories and workshops.

Arc Lighting in America and Europe.

AN interesting comparison of lighting systems in Europe and America was made in a paper read by Mr. C. Wiler before the Chicago Electrical Association, on April 16, an abstract of which was presented in *The Electrical Engineer* (May 5). The author claims for America the honor of being the birthplace of series arc-lighting, and asserts that, while, up to date, this system has scarcely gained a foothold in Europe, its application has been brought to a high degree of perfection in the United States. At the time the Brush and the Thomson-Houston dynamos were first introduced, the system of series arc-lighting was also introduced in England, and some of the original installations of the system are still in operation. Few additions to these installations have been made, and Mr. Wiler regards the method as now nearly abandoned in England. "The desire to supply arc and incandescent light as well as motive power from one and the same generator, the once low efficiency of arc dynamos, the use of small high-speed units, the consequently inferior arrangement of the steam plant, and, last, but not least, the high pressure for interior lighting" are causes influencing European opinion against the system of series arc-lighting. The force of some of these objections has been lessened in the United States by increase in the size of power units, decrease of dynamo speed, and increase in commercial efficiency. "The commercial efficiency of a 60-light dynamo now reaches 82 to 83 per cent., and of a 100-light about 86 per cent. Since the speed has been decreased to about 800 revolutions per minute for 60-light dynamos, and to 500 to 600 revolutions per minute for 100-light dynamos, it has been made possible to escape that labyrinth of counter-shafts, belts, pulleys, clutches, and bearings which for many years was characteristic of an arc plant." The direct connection of the dynamo with the steam-engine is the logical outcome of this advance. All this has naturally led to the predominance of series arc-lighting in America; and, although "arc-lighting by constant potential circuits was developed much later than in Europe, it has come into extensive use here since 1891, especially in large cities, for private lighting." Mr. Wiler's paper includes an illustrated description of the combined arc and railway plants of Munich; a table of data relating to various public arc-lighting plants in Europe and America; and an account of some particulars of European practice as contrasted with American.

Swiss Chalets.

A REMARKABLE, as well as a very interesting, exhibit at the Geneva National Exposition held last year forms the subjec of a leading article by Jean Schopfer in *The Architectural Record* (April-June), which, by the use of half-tone illustrations and descriptive text, conveys as good an idea of the actual exhibit as could be attained by those who did not actually attend the Exposition and study for themselves this feature of it. The exhibit comprised what was called a Swiss village, but it was probably unlike anything now to be seen in any one Swiss village, because it represented "one of the most interesting, and certainly the most original, chapters in the history of Swiss art,—that of house-building in wood,—and it was important that visitors should have before their eyes a picture of the surroundings amid which former generations passed their lives, and should see what a thorough and charming

sense of art, what graceful and picturesque originality, had been displayed by Switzerland in that architecture which is peculiarly her own." The arrangement upon historical lines which the carrying out of this idea compelled formed a unique and instructive representation of Swiss châlet architecture. Each house, or châlet, exhibited "exists, or did at one time exist, in reality; each has its date, its place of origin, in fact, its identity, fully established." The faithfulness of the reproduction was carried into every detail, and the exhibit was not representative in name merely, but in fact. The examples presented comprised "every architectonic form of wooden house, from the humblest and most modest, such as the little châlets (*mazots*) built high up on mountains to shelter the cowherds in the summer time, to the richest and most artistic creations in the way of carved and painted façades adorning châlets of the valley and of the plain, handsome inns, or dwellings of well-to-do farmers." In this successful attempt to reproduce a national feature, Mr. Schopfer sees "the revival of a style, and the restoration to a place of honor of a mode of house-building which can be employed at the present day, thus resuscitating a variety of most agreeable architectonic forms." These forms originated in the art of wood-working; carpentry, not the art of the stone-mason or the brick-builder, is the fountain from which they sprung. Mr. Schopfer criticises severely the wooden colonnades, frontons, attics, and porticos, so frequently found in American wooden buildings, and denounces this perversion as being "nothing less than an architectural heresy," and as a complete jumble of the most elementary principles of the building art, comparing it in this respect with an attempt "to reconstruct the Parthenon in iron." A contrast between the interior finish of Swiss châlets (wherein the beautiful natural effects of the wood are sought as much as possible) and the painted interiors of so many American houses is made, very much to the disadvantage of the latter. "In Switzerland, where the wood-working art has flourished and created a style, instead of masking and hiding the material employed, every effort has been exerted to make the most of its decorative properties; hence the joists are exposed, the projections of the upper floors emphasized, and the joints left uncovered; the roofs are developed, and the eaves extended, protecting the house and producing the finest decorative effect imaginable with their supporting brackets. Inside, wood forms are the basis of the ornamentation; the walls are wainscoted, and the beams left visible in the ceiling. This is the natural and logical decoration of the châlet. Following in this way the most simple and the most evident principles, a style of architecture has been created which is full of grace and originality." The disappointment the reader would otherwise feel because more of this interior work has not been made the subject of illustration is avoided by the promise made near the conclusion of the article that such a presentation will be made in a future number.

The Advantages of Down-Draft.

THE natural course for heated gases surrounded by a cooler medium is upward. It has probably occurred to many readers that, as carbonic acid and water are the principal products of the combustion of fuel, and as both carbonic acid and water at ordinary temperatures are heavier than air, if these products could have their heat usefully extracted till their temperatures were reduced to that of the atmosphere, they would, instead of rising, flow downward. Could this be realized in practice, we should have a natural down-draft. The modern down-drafts in furnaces are artificially produced. In a paper read before the St. Louis Association No. 2 of the National Association of Steam Engineers (April 27) and reported in *Sanitary Plumbing* (May 1), Mr. A. B. Hazard makes strong claims for the advantages of down-draft, in the application of which the green coal is placed upon the top of the fire, and the air is forced downward through the grate. He claims that in this system there is (*a*) complete combustion of gas; (*b*) a complete combustion of the fuel; (*c*) no deposit of soot

or tar; (*d*) a positive and rapid circulation of water in the water-tube grates, which, with down-draft are in the hottest part of the fire; (*e*) no cooling of the hot furnace and boiler by throwing open the doors of the combustion chamber, as in the up-draft systems; (*f*) much greater durability of grates; (*g*) increase of steaming capacity over that of boilers of the same size fired in the ordinary way; and (*h*) perfect smoke consumption. Of course, if these claims are sustained in practice, the logical result, increased efficiency, must inevitably follow. This is claimed to be from "ten to fifty per cent., depending on the kind of boiler, and upon other conditions." We do not desire to be understood as endorsing the claims made by Mr. Hazard, but we present them, in substance, for what they are worth as indicating merit in the down-draft system.

The Michigan College of Mines.

THE name of the institution formerly known as the "Michigan School of Mines" has, under an act of the legislature, been changed to the "Michigan College of Mines." Further legislation has fixed the rate of tuition in favor of the residents of the State. The rate for non-residents within certain limits is left to the determination of the board of control of the college. This latter rate has not yet been fully decided, but we are informed that it is likely to be $150, while for residents it will be only $25. The probable charge for non-residents will correspond with tuition fees in other first-class American technical schools. A letter from secretary F. H. Scott, says that, "when the school was working out its policy, and trying to solve its educational problems, it was thought wisest to charge no tuition, but to collect as wide a constituency as possible, in order that there might be all possible chance to make the methods as broad and thorough as could be done. It was also deemed hardly just to the students educated here to demand tuition until the institution was much better equipped for its work than the appropriations granted during the first decade of its existence permitted. Now that success has been attained in educating men for practical work, as is evidenced by the positions which its eighty six graduates hold,—a list of which is given in the last catalogue,—the institution seems fully warranted in charging hereafter for its instruction. The new law goes into effect immediately after August 19, 1897, and will therefore not apply to students entering previous to that time. A prospectus will soon be issued by the college, giving the details of the regulations finally adopted by the board of control.

Glowing of Disconnected Incandescent Lamps.

IN March, 1893, Mr. N. S. Amstutz published an account of observations upon the glowing of disconnected incandescent lamps excited by friction of the hand upon the bulbs. The observations were made in September, 1892. The original announcement was made in *Electricity* (March, 1893), and in the same paper (May 12, 1897) the same author presents an account of an investigation of light that can be produced in this way. Instead of friction generated by the hand, he employed in this investigation (March 27, 1897) a tube of transparent celluloid, into which the bulb of the lamp was introduced and rotated to generate the required friction. The base of the lamp was attached to a short shaft or spindle, upon which a small belt-driven pulley was fastened. The results obtained confirm, he asserts, the estimates made in 1892 upon the amount of power required to generate a unit of illumination, which was then determined to be about 45 per cent. of that required in ordinary practice. The quantity of illumination thus obtained with a single lamp is, however, small. The facts presented in the article enable an experimenter to demonstrate with very simple apparatus a number of the phenomena connected with vacuum tubes. An illustration of the apparatus is also given.

THE BRITISH PRESS

Railway Communication With India.

IT certainly seems wonderful, when the closeness of the long-standing ties which bind the East Indian colonies to the mother country are considered, and when, at the same time, the extension of railway communication during the last quarter of a century is regarded, that persistent efforts for facilitating railway transit between these lands have not been made. On the contrary, in a paper by Mr. C. E. D. Black, published in the *Journal of the Society of Arts* (May 7), he states that "practically nothing has been done to carry out the idea . . . Between the two countries there is a never-ceasing stream of officials, soldiers, sailors, merchants, and miscellaneous travellers, to say nothing of wives, children, and servants, which, though it flows more copiously during the cold season, never dries up, and is a striking criterion of the enormous bulk and the supreme importance of the commercial and administrative intercourse between the Indian empire and Great Britain." Mr. Black says, no doubt with truth, that the government of this empire of 270,000,000 inhabitants from a base six thousand miles away is not rivalled in the entire world, and it might well be added that it has no precedent in the history of the world. His proposition that it is of the highest importance "to shorten communications between the two countries . . . especially in the case of war, mutiny, or any great or sudden emergency," seems self-evident, but an inquiry into the possibilities of the case shows that routes geographically the most desirable are, for political reasons, not available. "As Europe, Asia, and Africa lie across our direct road to the east, it behooves us to consider carefully how to select the route which shall be, as far as possible, secure from molestation or interruption at the hands of others, and which shall lie within our own sphere of influence and control. I am afraid this important condition at once rules out the idea of a grand trunk line which shall begin at Calais, and, passing through Constantinople and Asia Minor, emerge at Candahar or Peshawar. Not that I mean to deny the possibility or the advantage of such a line; for improved railways mean enlarged intercourse and the strengthening of peaceful bonds between nations. But no such trunk line, traversing the actual arena of international jealousies and complications, and passing through the very focus of the eastern question, will fulfil the idea of a British imperial line designed to bridge over the physical gulf between Great Britain and her possessions in the East. Fortunately, so long as we have posssession of the Mediterranean, the necessity for quicker transit over the western or European half of the route to the east is not felt so much. It is difficuit to conceive of any possible political combination which would deprive us, all at once, of Marseilles, Brindisi, and Salonica entrepots in time of peace, or of the Mediterranean itself in time of war. The Cape route is, of course, available in the last resort, but I assume that we shall always cleave to the Mediterranean route, come what may, and our tenure of Gibraltar, Malta, Cyprus, and Cairo, are, I take it, very substantial and solid guarantees of this national determination. It is when we reach Egypt, the half-way house, that the question suggests itself, now that we have emerged from the nervous and energetic sphere of busy European rivalry into the calmer atmosphere of oriental repose: Cannot we choose a shorter cut than the long round-about Red sea and Indian ocean route? Look at the map, and you will see what a huge obstruction is presented by the enormous peninsula of Arabia, which juts out southward for over two thousand miles, causing a wearisome detour of from two to three days down the Red sea, while the further transit across the Arabian sea to India is of equal, and sometimes longer, duration. A straight line drawn as the crow flies, from the northern end of the Suez canal to Kurrachee, or whatever we may fix upon

as the western land gate of India, coincides with the route which, I venture to say, is the shortest and best line for a railway to India." Mr. Black admits that he hazards something in so strongly recommending a line yet unexplored either by himself or others; but, as various sections of it have been traversed without discovery of any important obstacles to railway construction, and as he has, in the geographical department of the India office improved the excellent opportunities there afforded of studying the geography of the region the proposed road would traverse, he feels justified in his belief in the route. At any rate he thinks that it presents attractions sufficient to warrant its exhaustive investigation before the consideration of any other scheme.

Is the Pacific Cable a Practicable Scheme?

WITH reference to the supposed difficulties to be surmounted in the laying of this proposed cable, *The Electrical Review* (London, April 30), criticising an article which recently appeared in the *Electrical Engineer* (New York), says that business men, both in Canada and England, have been convinced for many years that such a cable would have a sufficient earning capacity, but that "the interests of a powerful combination of telegraph companies controlling the network of cable and land-lines now serving the needs of, practically, the whole civilized world have been made the most of to create doubts, now happily dispelled." Exception is taken to the views of our New York contemporary with reference to the difficulties of the scheme, regarded from an engineering stand-point. Of these the most prominent arise from what the *Electrical Engineer* styles "the extreme lengths between landing places," and "the enormous depths." In its discussion of these points, it is charged that the language used is such as to lead "the casual reader to infer that 7,000 miles is the length of one section, instead of being somewhere about the length of the entire system." It is then claimed that, as the longest section of the cable would really be about 3,500 nautical miles, a working-speed of fifteen or eighteen words per minute could be easily attained over this section. A further criticism is made upon the use of statute miles in expressing depths, nautical miles, or fathoms, being preferable in comparisons of the Atlantic and Pacific for cable purposes. On this point *The Electrical Review* says: "The former runs the latter pretty closely in the matter of depths. Between Bermuda and Porto Rico, for example, on a line of soundings, there are depths of from 2,875 fathoms near Bermuda to 3,875 fathoms near to Porto Rico. The deepest sounding in the Atlantic yet discovered is in close proximity to this latter island, where the depth encountered is 4,561 fathoms, and not 4,620 fathoms, as our contemporary believes. Another line of soundings from Porto Rico towards Charleston, U. S., shows depths of from 2,990 fathoms to 3,133 fathoms. There are soundings between Africa and the West Indies of 2,500 fathoms to over 3,000 fathoms. Yet this would not deter the Spanish government from laying a cable to Cuba, if they possessed the funds necessary. In the South Atlantic, between Ascension Island and the River Plate, is a line of soundings with over 3,000 fathoms at the deepest part." It is then shown that, while soundings of from 5,022 fathoms to 5,155 fathoms have been made in the Pacific, the extreme depths lie outside the track of a cable. Thus, between New Zealand and Fiji the average of many soundings is 2,500 fathoms; between California and the Sandwich Islands the deepest of abundant soundings is 3,000 fathoms; between Vancouver and the Sandwich Islands, 3,115 fathoms is named as the greatest depth. It is admitted that between the Sandwich group and Japan there are soundings of from 4,000 to 4,643 fathoms, but it is claimed that these are in deep gorges that may and would be avoided in laying cables. It is held that other exceptionally great depths in the Pacific are in so isolated positions as not to interfere with cable-laying. It is also claimed that the problem of successfully laying a Pacific cable has already been "solved in theory by practical engineers on both sides of the Atlantic"; that

"the deepest Atlantic cable lies in 2,850 fathoms"; "that no great difficulty was experienced in laying it," and that the idea that volcanic action, in its disturbance of the sea bottom, is more to be dreaded in the Pacific than in the Atlantic Ocean is not sustained by facts. A further criticism is made with reference to the temperatures of the two oceans, the differences in which (it is asserted in opposition to the statement that deep water is colder in the Pacific than in the Atlantic) "are not appreciable at depths greater than 3,000 fathoms. Exception is also taken to the speculative belief that the increase of pressure at great depths would adversely influence a well-constructed, light, armored type of deep sea cable: and it is calculated that the maximum pressure to which such a cable would be subjected on any possible route for a Pacific cable would be 3.9 tons per square inch.

Fire-clay Building Materials.

THE large and increasing employment of fire-clay manufacturers in building justified the presentation of a paper upon these products, read by Mr. W. H. Allen before the Northern Architectural Association (Eng.), and reported in *The Architect & Contract Reporter* (April 30). The paper relates principally to the manufacture of sanitary pipes and specialties, glazed bricks, scullery sinks, white channel bands, closets, etc. Of course the quality of the articles manufactured depends, first, upon the quality of the material, and, secondly, upon the knowledge and skill applied to the manufacture. In order that architects and builders may be able to judge wisely of the quality of fire-clay goods, they ought to possess a general knowledge of the material, of the sources whence good qualities of fire-clay can be obtained, and of the methods whereby the plastic material is converted into a hard, strong, impervious mass, shaped into desired forms. In England fire-clays are found in abundance in the coal measures of Northumberland and Durham, most frequently as the floor or under-stratum of seams of coal, and in layers from one to six feet thick. It has a slate grey color, and the better qualities, free from impurities, have a greasy feel. Fire-clays are chiefly composed of silica and alumina in varying proportions, a fair average for the English clays being fifty to fifty-five per cent. of silica, and thirty to twenty-seven per cent. of alumina. Of course, the greater part of the fire-clay output is used for heat-resisting purposes, but this, being aside from the author's purpose, is passed with only brief mention. In Corbridge, Eng., a special kind of fire-clay, of very fine quality, is obtained. It lies apart from the coal measures, has a reddish brown tint, and, when burned, acquires a very dense body, similar to that of stoneware. The first step in the preparation of fire-clay for manufacture is the grinding into powder of the required fineness (according to the articles intended to be made) of the large, hard lumps as they come from the pit.

For heat-resisting purposes the clay is coarsely ground; for salt-glazed goods finer grinding is needed; and for white goods the finest grinding of all is required. For the latter purpose, also, great care is exerted to procure clay free from nodules of ironstone. The latter, when present, fuse in the kiln, and ruin the product, The grinding is effected by the use of a revolving pan, within which are two metal rollers. From the grinding mills the ground clay is carried by elevators to a revolving riddle, by which it is separated into parts of the required different degrees of fineness. Mr. Allen says that this treatment has largely superseded older methods, though the latter are still more or less retained. The general steps of the manufacture are the moulding and burning, the first being largely performed by moulding machines, and the latter in kilns adapted to the kind of articles manufactured. Moulding gives the required form, and burning the required solidity, strength, and rigidity. Salt glazing is done when the kiln is at its hottest stage of firing. It is extremely simple to do, but the chemical reaction which forms the glaze is not quite so simple, although easily enough understood by chemists. When the right period arrives, and the

heat has risen to a point sufficient to volatilize common salt in, say, a kiln for burning sanitary pipe, several barrowsful of the salt are thrown into the kiln. This salt, vaporized by the heat, permeates every part of the kiln, and, aided by the watery vapor, also present in the kiln a chemical reaction between the salt vapor and the silica of the clay articles takes place, the result being the permanent vitrous surface or glaze with which every one is familiar. Glazed bricks are surfaced in a different way. They are first burned to only a moderate degree of hardness, then taken from the kiln, dipped in a liquid glazing material, and then reburned. Few have a clear idea of the amount of labor needed to manufacture glazed bricks. Each brick has to be handled twenty times. The conduct of the various processes to a successful issue require the exercise of great judgment and care, and sometimes great loss is incurred by failure, as in the improper mixing of the body and glaze. This requires the utmost exactness; a very slight error in weighing may cause the bricks either to craze, or not to glaze properly, according as the error is one of excess or deficiency. The manufacture is, therefore, notably one which entails serious risks. There are two systems employed in the manufacture of white goods, such as scullery sinks, etc. In some cases twice firing and glazing, as with glazed bricks, is practiced; in others the body and glazing material are applied with a brush, and a single burning suffices. The choice of methods depends upon local conditions. On the whole, the entire line of fire-clay goods used in building probably exacts from manufacturers a greater degree of care, and entails more risk, than any other class of materials used in modern building construction.

Gravity Stamp-Mill Practice.

THE first part of a paper comprising an account of an important study of the mechanics of gravity stamp mills is printed in *Industries and Iron* (May 7). The author is Mr. D. B. Morison, who read the paper at a meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne (April 30). The study has a direct practical application to the increased efficiency and durability of gravity stamp mills, to which appliance (improved principally by American engineers) the change in the status of gold mining from a purely speculative to a thoroughly-organized, standard, and permanent industry is largely due. Though hardly needed for his purpose, the author introduces the subject with a general statement of the function of the gravitation stamp mill, and an account of the crude forms used in the Hartz mines, Germany, and the Cornish mines from which the modern stamp mill has been evolved. The general construction of a gravitation stamp mill is illustrated by engravings, and an analysis of the action of this class of mills, and the physical law that would control the fall of the stamps in the absence of friction,—*vis inertia* and the resistance of the material to be crushed,—is made. But, as it is obvious that the conditions named materially modify the action of the law of gravity in stamp-mill practice, the extent of this modification becomes a proper subject for experimental investigation, and the account of such a research is embodied in Mr. Morison's paper. This part of the paper—illustrated by diagrams—shows very clearly the shocks, strains, and vibrations to which stamp mills may be, and too frequently are, needlessly subjected. The stamp, if an attempt be made to make it drop too often, may in its fall meet the lifting cam, the latter rotating too fast to synchronize with the fall of the stamp. The stamp, if lifted too quickly, will, by its *vis inertia*, move higher than the cam is intended to lift it. It takes time for the stamp to pass upward and return through this superfluous distance. The friction is also a retarding force of varying magnitude, not only in different mills, but in the same machine. These elements unite in imposing limitations of speed upon the operation of stamp-mills, and as the theoretical time in which the stamps drop through a given distance is less than the actual time required in practice, there is no way of determining the practical time limit by

calculation. Only the experimental method remains. The method of carrying out these experiments, the graphic method of expressing results, and the data required are embodied in the paper. It was, for example, ascertained that "a cam stamp having a seven-inch drop cannot be driven at more than from ninety-four to ninety-eight drops per minute" in ordinary work, and that the combined effect of the elements of resistance reduced the efficiency of the drop by seventeen per cent., as compared with that of the same weight falling freely *in vacuo*. In practical work a reduction of efficiency of from twenty to twenty-five per cent. is a probable average. Since gold mining has now come to rank with other permanent industries in the matter of profits made by rigid enforcement of economies, the loss of efficiency in stamp-mill practice is not insignificant, nor will it be anywhere considered a negligible factor in the cost of getting gold.

Carbureted Water Gas as an Enricher of Coal Gas.

It is well known that serious objection has been made to the use of carbureted water gas as an illuminant in dwellings on account of the proportion of carbon monoxid it contains as compared with coal gas. The water gas escaping into a room from a leak or from an imperfectly-closed gas tap is, on this account, considered more dangerous to life than coal gas. Carbureted water gas sometimes contains as much as twenty-eight per cent. of carbon monoxid, while coal gas does not usually contain more than six or seven per cent. But, while the use of carbureted water gas by itself may be thus more dangerous than the use of coal gas, it is possible and practicable to use water gas as an enricher of coal gas without much enhancing the risks to life and health through accidental leakages, and without material reduction of lighting and heating values. A summary (*The Gas World*, April 17) of a recent report made by Professor Lewes to the Birkenhead gas committee will allay some apprehensions that have existed relative to the use of water gas as an enricher. Professor Lewes concludes that there is no danger in sending out a mixture of coal gas and carbureted water gas, provided the mixture does not contain more than seventeen per cent. of carbon monoxid, and that such a mixture is, for all practical purposes, as good as coal gas, and superior to coal gas for incandescent lighting. The data and reasons upon which these conclusions are based are given. In examinations of coal and cannel gas, he found an average of 5.99 per cent. of carbon monoxid. In carbureted water gas he found an average of 29.03 per cent., the highest percentage having been 29.78. In the coal gas enriched by the carbureted water gas, as sent out, he found the mean percentage of carbon monoxid to be 14.49, the highest percentage being 14.50,—2.50 per cent. less than the maximum percentage of carbon monoxid above stated as permissible. In answering the question as to what percentage of carbureted water gas can with safety be mixed in a town supply of coal gas, Professor Lewes avows his appreciation of the grave responsibility, and states that he would decline to answer, were it not that in his position as superintending gas-examiner to the corporation of the city of London, he has been obliged to consider very carefully to what extent carbureted water gas can be allowed to replace coal gas without danger to the consumers. He alludes to the fact that carbon monoxid is the most dangerous gaseous poison there is, and he condemns the attempt made by some supporters of water gas to conceal this fact. He believes that the only proper way to meet this question is to concede the dangerous properties of the gas, and to so arrange the percentage of it, when used for enrichment, that only under abnormal and accidental conditions, impossible of prevention, need the risk of its use be dreaded. "The breaking of a gas main near the basement of a house and infiltration of large volumes of gas into the house itself, the fall of a chandelier, or a serious leakage from it when pulled too low, and the accidental cutting into a supply-pipe in a wall, would all give leak-

age of a sufficiently serious character to form a poisonous mixture, fatal, in time, to life, whether the escaping gas were coal or carbureted water gas, and this class of accident must be put aside. The smell of carbureted water gas being even more penetrating than that of coal gas, a leakage becomes perceptible to the nose when the air contains one ten-thousandth part of the gas, which proportion would be absolutely without action on health." From this it follows that only during sleep could a leakage of carbureted water gas become dangerous to life. "The usual chances of leaks are from such unlikely circumstances as the gas being blown out,—an extremely difficult thing to do,—or being extinguished by collection of water in the supply-pipes, or by an irregularity in the working of the meter"; and Professor Lewes asserts that, in a fairly long experience of coal-gas consumption, no such instances have come to his knowledge. He does not on that account deny their possibility. Both carbureted water gas and coal gas have practically the same illuminating value; the same fittings and burners answer for both. The mixture of coal gas with carbureted water gas gives off about two and three-fourths per cent. less heat than coal gas when used in stoves, cookers, and engines,—a percentage quite immaterial. The products of combustion of such mixtures are no more unfavorable to health than the products of combustion of coal gas alone. Carbureted water gas is freer from sulphur compounds than coal and cannel gas, and therefore its products of combustion are less injurious to books, gilding, etc., in apartments than are the products of combustion of coal gas. The enriched coal gas is more suitable for incandescent mantle burners, because it deposits less carbon on the mantles, and thus less light is lost.

The Mussy Viaduct.

THIS specimen of engineering is about the only feature of more than ordinary interest on the recently-completed railway from Paray-le-Monial to Lozanne and Givors in central France. It was designed by MM. Geoffroy, Moris, and Ponthier, engineers of the Paris, Lyons & Mediterranean Railway Company, and the design was carried out by MM. Vaysserye. From an illustrated description of this viaduct in *Engineering* (April 30) the following abstract, setting forth interesting features of the construction, has been prepared. The total length of the structure is about 1,800 feet, and it is built wholly of masonry. Five of the nineteen piers have a height of 197 feet from the ground to rail-level. "The lower parts of the piers form pedestals, in the highest piers at a height of 42 feet; at this level there is a set-off of 12 inches, from which the shaft of the pier rises, interrupted at intervals by courses of cut stone." The contractor's plant for carrying out the work comprised five miles of railway, exclusive of an extensive system of branch narrow-gage railways, the latter leading from the central power station, where the cement and mortar were prepared, and the former extending to the quarry from which the stone was obtained. It having been impracticable to obtain sand for admixture in the mortar and cement, pulverized granite was substituted. A special plant for the supply of this material was thus necessitated, consisting of crushing, grinding, screening, and washing appliances. "Water was obtained, from an adjoining canal situated at a higher level than the stream in the Mussy valley, and turned into a large basin, in which the screened granite was deposited; from this basin it was discharged through a sloping channel, in a stream having considerable velocity, into a second basin some forty yards distant, where the pulverized granite was allowed to settle, the water being run off into the Mussy." Three of these washing arrangements were employed. No difficulty was experienced in erecting the pedestals of the piers. The method of erecting the tall shafts of the piers above the pedestals was adopted with a view to cheapness as well as efficiency. It dispensed with scaffolding, which would certainly have cost much because of the height of the piers, and was found to be wholly satisfactory in its application. It is described as follows: "To meet this difficulty . . . MM. Taysseyre con-

structed a sufficient number of light, easily-erected or removed girders of such a length that they could take their bearings on the completed bases of the piers. The ends of these girders were fitted with lifting screws, and they served as convenient platforms from which to hoist material and to proceed with the erection of the piers for a suitable distance. As soon as the convenient limit was reached, the girders were raised by the lifting screws and the erection of the piers proceeded with. In this manner all the piers were completed without the aid of scaffolding. Only a limited number of these platforms were constructed, in order to save expense, so that the work of completing all the piers was not carried on simultaneously, but, as soon as two piers were completed, the platform was lowered, taken apart, and re-erected on another part of the viaduct." These platforms were 88 feet long and constructed for a safe load of six tons in the middle. On their floors were laid two lines of narrow-gage railway, with crossings and turn tables for the trolleys. The piers were connected at the springing level by five steel cables, at intervals of 65 inches, attached to cramps let into the masonry. Planking was laid on these cables, which were tested to a central load of two tons. "The timber was raised by tackle operated from a fixed hoist. As soon as the centring was completed, a temporary gangway about ten feet wide was erected on it for the whole length of the viaduct, and two tracks of 20-inch gage were laid down to allow of the transport of material to any desired point." The stone was hoisted from the bottom up the slope of the valley on an inclined plane, by a steam winch which hauled the stone-laden trolleys up the plane and on to the temporary gangway, the empty trucks returning by gravity. It is evident that the methods employed in the construction of this bridge are an example of engineering that can be profitably studied, and that will probably be followed in the erection of future viaducts requiring piers of unusual height. The data of cost are not presented in the article reviewed.

Electrical Action of Carbon in Flames.

It is a fact that, notwithstanding all that has been accomplished in the field of electrical discovery, the attitude of the public mind toward electric research is that of confident expectation. This attitude is maintained by the frequent announcement of discoveries—results of experimental investigations—which, while not in themselves revolutionary, or, so far as present indications go, even calculated to initiate any important change in current practice, are yet of a character to show how narrow is the margin of the field already cultivated, and how broad and rich is that portion yet untilled. Among recent discoveries which seem to disclose vistas of future possibilities may be classed the results of experiments communicated to *The Electrical Review* (May 7) by Richard P. Fuge. These results indicate that a battery producing a small current of high electromotive force can be constructed, in which the positive plate may be of carbon, or in which carbon in different allotropic conditions may be used for both positive and negative plates. If platinum electrodes are inserted in a flame and connected by a conductor, a current passing through the conducting wire indicates that different parts of the flame have different degrees of electromotive force. By adjusting the electrodes in the flame, the portions of the latter possessing the same electromotive force can be determined. The experiment can be varied by using two electrodes of different metals (*e.g.*, zinc and copper), both placed in a part of the flame having a uniform electromotive force. In such a case a current will pass through the conductor corresponding with the difference of electromotive force in the two metals. Now Mr. Fuge has gone still further in this line of experiment by employing electrodes of carbon instead of metal, using high insulation, taking care to place the electrodes in flame at the same potential, and measuring the results by a high-resistance Kelvin reflecting galvanometer, and a condenser of one microfarad capacity for comparing the electromotive force generated with a standard Daniell cell. In this way he has been

able, he asserts, to sometimes produce an electromotive force higher than 1.7 volts between a positive plate of wood charcoal and a negative of plumbago. Analogous results were obtained with retort carbon used as a negative electrode. For other interesting phases of this series of experiments, the reader is advised to consult the original paper. With reference to a successful repetition of experiments of this kind Mr. Fuge says: "The wood-charcoal used must be thoroughly carbonized; otherwise its resistance may be so high that no result will be obtained; the charcoal that was used with the best results is that sold as 'blow-pipe charcoal.' In most cases its resistance was measured beforehand. . . . The retort charcoal was, in all cases, the ordinary rod-carbon used in arc lights." Of course it is quite useless to speculate about what may be the practical outcome of this discovery, which throws additional light upon the problem of the generation of electricity directly from carbon.

Automatic Extinction of Lamps.

AN ingenious arrangement of street-lighting, which allows a reduction of the illumination at any time when less light is needed, is described in the *Electrical Review* (March 26). This arrangement is now in use in several places, but Portsmouth, England, is considered a notable instance, as the system has been successful there. It appears to be a system of automatic switches. "The automatic switch, which is being used on 240 lamp-posts, is designed so that, when the arc lamps are turned off, the incandescent lamps are automatically lighted." It ought to be explained that each lamp pillar has an arc lamp as well as two incandescent lamps, the latter being employed during the period when the lesser illumination is desired. "The device consists of a coil in series with the arc light, and, when the arc lights are burning, the coil becomes energized and attracts the end of a lever; when, however, the arc lamps are extinguished, the rocking arm drops down upon a knife-edged switch, and this action has the effect of completing the incandescent circuit, thereby turning on the glow lamps." The paper quoted illustrates this arrangement by engravings which cannot here be reproduced.

The operation, however, is so simple that its general features may be understood without engravings. When the lever spoken of drops, the incandescent circuit is completed, the current passing through a tube straight to the lamps, returning to the switch through the arm of the lever and out again. This provides for the lighting of the glow lamps at the instant of extinguishing the arc light. The extinguishing of the incandescent lamps, in their turn, is accomplished by sending a reverse current through the arc lamps and consequently through the coil, thus lifting the lever out of the switch and cutting out the incandescent lamps. To prevent the lever from falling back again into the switch, a permanent magnet is pivoted under the solenoid in such a manner that it may move horizontally. This magnet carries a catch, which, passing under the arm of the lever, holds it from falling back on to the switch when the current through the series coil is interrupted, while, at the same time, it permits the core of the solenoid to drop down to its original position. To insure that the lamps are all effectually cut out, the reverse current is turned on for about five minutes. When the current for the arc lights is sent through the lamps, the pivoted magnet which operates the catch is drawn back into its original position, which leaves the lever free to act, according as the coil is magnetized or demagnetized. The use of this apparatus in Portsmouth is estimated to have saved the wages of three men.

THE FRENCH AND GERMAN PRESS

The Supporting Power of Soils.

WE have already noticed in these pages the apparatus devised by the city engineer of Vienna, Herr Rudolf Mayer, for measuring the supporting power of soils. Herr Mayer now contributes to the *Oesterr. Monatschr. für den oeffent. Baudienst* for March a fuller account of his experiments, with scale drawings not only of his precise apparatus, but also of a less delicate and more practical device for general use by builders and by superintendents of building operations. The basis upon which such tests should be made is that of the rate of yielding to pressure. Up to a certain limit the depth to which a given loaded area sinks is directly proportional to the load which it bears, and this limit should in no case be exceeded. Herr Mayer's simple apparatus is intended to determine this limit with a degree of precision amply sufficient to enable the builder to proceed intelligently. As already described, the original apparatus consisted of a base plate and cylinder into which a plunger is fitted, and upon which weight can be placed corresponding successively to uniform pressures per unit of area. The corresponding sinking of the plunger into the soil is then very precisely measured by a micrometer upon a multiplying column, arranged with differential cylinders, and the results of systematic increases of pressure are plotted in a curve.

For practical use this apparatus is replaced by a rod carrying a divided head, upon which a tube containing a spiral spring is fitted. The end of the rod is provided with a number of tips of various determined areas, in order that one adapted to the nature of the soil may be selected; and, by pressing this upon various portions of the ground to be tested, and taking the readings from the spring scale, the relation between the pressure and the penetration may be obtained.

The entire subject is one upon which there is very little experimental information on record, and, while still further improvements may be made in the appliances for its investigation, Herr Mayer is to be congratulated upon bringing the matter to professional notice.

The Heilmann Electric Locomotive.

THE experiments made several years ago with the Heilmann electric locomotive by the Western Railway of France was sufficiently satisfactory to induce the management to undertake the construction of a larger engine, embodying the results of the experience thus gained, and the accounts of the performance of the new engine are given, with a full description and illustrations, in *Glaser's Annalen* for April 15.

The Heilmann locomotive is practically a travelling power-house, carrying its own boiler, engines, generators, and motors, and hence hardly realizes the popular idea of an electric locomotive as a sort of mammoth trolley car. The actual advantages expected from the Heilmann type of engine are to be gained in the elimination of all the reciprocating parts, the introduction of high-speed compound engines, the possibility of small wheels on swivel trucks, thus giving a flexible wheel base, yet making all the wheels drivers, and the possibility of controlling, regulating, and reversing the speed of the locomotive without altering the speed or direction of the engines.

In the locomotive now completed the steam is generated in an ordinary locomotive boiler, and supplies two Willans compound engines, each engine having three pairs of cylinders, cranks being set at 120 degrees apart. The cylinders have a stroke of 7.6 inches and 12.2 inches by 10.15 inches running at 400 revolutions, and the two engines indicate 1,350 h. p. At each end of the shaft is attached a generator of the continuous-current type, built by Brown, Boveri & Co., supplying a current of 1,000 amperes and 455 volts, the whole of this machinery being placed longitudinally in the center of the locomotive, aft of the boiler. There is also an

auxiliary engine and dynamo for lighting the train.

On each of the eight wheel shafts is mounted a motor of 125 h. p., the armature of the motor being carried on an annular shaft concentric with the axle, and the speed being reduced by internal gearing. The total length of the locomotive is about 60 feet, and the weight 115 tons, and a speed of about 60 miles an hour has been attained.

While it seems a mistake to attempt the construction of a high-speed power house when so much of the plant might have been permitted to remain stationary, there is no doubt that many advantages will be gained by the removal of the reciprocating parts; and the experience gained with the Heilmann locomotive will do much towards convincing railroad men of the capacity of electric motors for heavy service. The Heilmann locomotive can run over any of the existing tracks without requiring the installation of any permament plant or line wire, and, when it is seen what can be done in this intermediate way, the introduction of stationary plants and general electric driving must follow. In the meantime the experience gained with this engine will be of much value, and its performance cannot fail to be watched with interest.

The Manchurian Railway

DOUBTLESS many reasons, of which the political significance will appear in due time, prompted the intervention of Russia between Japan and China in the recent war, and apparently one of those reasons has already shown itself in the proposed changes in the route of the Trans-Siberian Railway.

As originally planned, the railway, after crossing Lake Baikal, was to be carried through the Amoor province, following the valley of the Schilka and the Amoor, keeping entirely within Russian territory. The main line of the road is already completed to Krasnoiarsk, on the Yenesei, and construction is progressing to Lake Baikal, but explorations of the projected route along the Amoor valley have revealed the existence of dense forests, which make the (estimated) cost of construction more than $100,000 per mile; as this portion of the road would be more than 1,200 miles in length, the total is enough to cause hesitation and search for some less costly route.

The only alternative is to carry the road through Manchuria, thus passing into Chinese territory; two routes have already been surveyed, and plans made for the execution of the work.

As an offset to the objection of leaving Russian territory, numerous advantages will result from the change. The length of the road will be shortened by about 300 miles, the forests will be replaced by the plains of Manchuria, and the pass through the Chingan Mountains is much less difficult than that through the Yablonoi range, which the original plan included.

Negotiations with the Chinese government are said to have been satisfactorily concluded, and the entire road is to be completed within five years, thus giving Russia through communication by rail with the port of Vladivostock.

Full details of this portion of the road are given in the *Zeitschrift des Oesterr. Ing. und Arch. Vereines*, for March 19, with map.

The Development of the Gas Engine.

AT the recent expositions at Geneva and at Berlin there were no exhibits which displayed attention to points of development to a greater extent than did the group of internal combustion motors, including gas and petroleum engines; while no radically new engines were shown, the general line of improvement in proportions, performance, and general design was worthy of notice.

The exhibits at both expositions are fully reviewed in the issue of the *Zeitschrift des Vereines Deutscher Ingenieure* for April 10, with many illustrations, some of which are interesting.

The cost of coal gas has caused especial attention to be given to petroleum motors, and among these the portable engine of Altmann and the traction engine of Hartmann are of interest. In both of these engines the circulation of water about the

cylinder is replaced by a larger water jacket, in which no attempt at circulation is attempted, the water being allowed to reach the boiling-point and pass off as steam. Although this plan is adopted mainly because of the inconvenience of carrying water, in fact it occasions not only an economy of water, but also a higher efficiency of the engine, owing to the higher temperature of the cylinder walls. This is especially desirable in the case of petroleum motors, as the hot cylinder prevents the condensation of vapor on the walls, and adds to the certainty and effect of the explosion.

Among the gas engines, properly so-called, one of the best was a fine motor of 60 h. p., built by the Berlin Anhalt Machine Works. This engine, which was practically a well-designed motor using the Otto, or Beau de Rochas, cycle, developed on test 75.8 brake horse power with a consumption of 17.1 cubic feet of gas per horse power per hour, and gave the following high efficiency:

Heat converted into work...	31.5 per cent.
" rejected in cooling water.	20.7
" in exhaust and radiation.	47.8
	100.0

A novelty in the shape of a gas hammer was also shown, besides some very simple small motors, and it is evident that, with the advent of a suitable cheap fuel gas, of a character suited to be used in motors, the internal combustion engine will develop with such rapidity, both as to efficiency and capacity, as to crowd the more wasteful steam motor very hard for many purposes.

Petroleum as Fuel.

NOTWITHSTANDING the small use of petroleum as a fuel in the United States, its use on the Russian railways continues to increase, and that, too, without causing any alarming increase in the price of refuse. *La Revue Technique* (April 23) gives a review of the investigations of the Russian engineers, MM. Goulichambaroff and Arzich, upon the use of petroleum residues in locomotive-firing, showing that the advantages already made public in the papers of Mr. Urquhart and Sig. Soliani continue to be borne out in practice.

The method of burning the refuse is practically that which has been in use for a number of years, the liquid being pulverized by jets of superheated steam, concentric, flat, and annular pulverizers all being used. From three to five per cent. of the steam generated is used in the pulverizers, but, as the evaporative power of the petroleum is found to be fully fifty per cent. greater than that of coal, the net gain is still considerable, apart from the convenience of the liquid fuel in handling, and especially in prompt response to sudden demands for steam.

In the reports above referred to, figures are given only from 1890 to 1894 inclusive, but during that period the consumption of petroleum refuse increased more than one hundred per cent., while the increase in all solid fuels was only twenty-five to thirty per cent.

Swiss Steam Engines.

SWITZERLAND has long been noted for the excellence of the product of its steam-gine builders, and it was naturally expected that some superior examples of steam machinery would be found at the exposition at Geneva.

Full accounts of the engines there exhibited have been given in the *Schweizerisches Bauzeitung* for March 13, 20, and 27, as well as in the *Zeitschrift des Ver. deutscher Ingenieure* for March 6, with numerous illustrations. The leading exhibits were those of Gebrueder Sulzer, of Winterthur, and Escher, Wyss & Co., of Zurich, each firm being represented by several engines. The largest of these was a triple-expansion Corliss engine by Escher, Wyss & Co., of 600 h. p., the valve gear being of the Frikart modification, operating the release of the cut-off by the angular motion of the eccentric rod; but there was nothing new in this engine. The same firm exhibited a compound tandem corliss engine of 285 h. p., coupled direct to a dynamo of the Thury type. This engine was arranged with two eccentrics, of which one, fixed to the shaft, operated all

four of the valves at the low-pressure cylinder, as well as the exhaust valves of the high-pressure, while the other eccentric was connected to a shaft governor and controlled the admission valves only of the high-pressure cylinder. The trip cut-off is thus avoided, and the engine adapted for higher speeds, the one exhibited running at 135 revolutions. An engine of this design of 700 h. p. is used in the electric plant at Zurich with good results. Gebrueder Sulzer exhibited a handsome triple-expansion engine of 500 h. p., constructed with their well-known poppet valve gear. The high-pressure and intermediate cylinders were placed tandem on one side, and the low-pressure on the other, and a small engine was arranged for starting, by a ratchet gear acting upon the rope fly-wheel. Sulzer also exhibited a tandem compound vertical engine with large piston valves, one of these being operated by an eccentric placed in the middle of one of the main bearings, which is divided for the purpose,—an arrangement of doubtful advantage.

One of the most notable machines shown was a powerful compound air-compressor, built by Burckhardt, of Bâle. This consisted of a double-cylinder steam engine, with cylinders of 25-inch bore and 23⅝-inch stroke, the piston rods being prolonged through the rear cylinder heads to the air cylinders. The high-pressure air cylinder was 20⅛ inches and the low-pressure 31⅛ inches in bore, both cylinders being provided with peculiar combination valves. These resembled ordinary plain slide valves, except in having the outlet valves mounted on them, the air admission being controlled mechanically by eccentrics independent of those operating the steam-engine valves, and the discharge valves opening by air pressure. At 90 revolutions this compressor had a capacity of 1,766 cubic feet of air per minute, compressed to 70 pounds per square inch. Altogether, the steam-engine exhibits at Geneva showed that, while Switzerland maintains its already high reputation for excellent design and high-grade workmanship, no new details or principles have been there developed in recent years.

The Production of Very Low Temperatures.

We have already noticed in these columns Prof. Linde's apparatus for the production of very low temperatures and the liquefaction of various gases,—among them, atmospheric air. Prof. Linde contributes a full discussion and description of his apparatus and its operation, together with some investigation of the resulting products, to *Glaser's Annalen* for March 15 and April 1; and, as the whole forms an important contribution to mechanical physics, it is worthy of further notice here.

After exhibiting diagrams showing the behavior of various gases under compression at different temperatures, Prof. Linde reviews the methods heretofore used for reaching the critical points of gases. The experiments of Cailletet, Pictet, and Dewar are described, and the complicated nature of the methods involving successive cooling by means of previously-liquefied gases is shown.

The idea of using air compressed, the heat of compression removed and the expanding air used to cool a fresh quantity of compressed air, is shown to have been first suggested by William Siemens in 1857, and subsequently revived by other investigators. Especial mention is made of Solvay, whose experiments between 1885 and 1895 showed that, although by this method theoretically any temperature down to that at which the gas liquefies should be attainable, yet a point was reached at which the losses equalled the gains, below which further progress could not practically be made. In a memoir presented to the Paris Academy by Cailletet in 1895 it was shown that at a temperature of—95° C. (—194° F.) the further abstraction of heat ceased.

Prof. Linde's new apparatus is a continuous one, the air being compressed and cooled by water to the temperature of the atmosphere, and then allowed partially to expand as it passes through a coil of pipe to a receiver. The coil is surrounded by a second coil, and in the space between the two pipes a portion of the expanded air is allowed to return to the compressor. The

returning air is cooled by contact with the exterior of the coil in which the expansion is taking place, and thus the compressor is constantly receiving colder and colder air, the action being cumulative, much like the self-excitation of a dynamo, until the critical temperature is passed, when the liquefied air is delivered into the receiver. A second compressor is then used to furnish air to make up for that withdrawn as liquid, and the process goes on continuously. The time required for the reduction of temperature is about two hours, after which the apparatus furnishes about one liter of liquefied air per hour continuously.

Among the researches which Prof. Linde has made are included determinations of the specific heat of air at various low temperatures and high pressures. He has also determined the theoretical and actual thermodynamic efficiency of the apparatus for various ranges of temperature, and shows an independent apparatus for the separation of mixed gases of different vaporizing temperatures by a sort of fractional distillation. In connection with this operation it is of interest to note that, in falling from a pressure of 22 atmospheres to 1 atmosphere, the portion of liquid air which vaporized was so largely composed of nitrogen as to leave a liquid composed of 70 per cent. of oxygen.

Improvements in Sterilization.

THE completeness with which disease-germs may be destroyed by the action of heat is well known, and many forms of apparatus have been devised for use in the convenient subjecting of food-constituents either to the boiling-point or, in the system of Pasteurization, to a temperature of 75° C., for a definite period of time. It has been found, however, that with many substances, such as milk, beer, wines, and others, the operation of sterilization partakes of the nature of cooking, imparting a peculiar taste, and sometimes materially changing the properties to an undesirable extent.

In a note recently presented to the Academy of Sciences by M. Duclaux, and given in *La Revue Technique* for April 10, the process of M. Kuhn is described as successfully removing this objectionable feature of sterilization in a very simple manner. The principle consists merely in subjecting the liquid to be sterilized to the desired temperature in a closed vessel under high pressure and out of contact with air. The apparatus is equally simple, the sterilizer being a steel tube silvered within, and surrounded by a steam or water jacket formed of a second cylinder of slightly larger dimensions. Suitable connections and stop cocks are provided, as well as thermometers and pressure-gages, and the apparatus is mounted so that it can be revolved by turning a crank.

The liquid to be sterilized—milk, for example—is introduced into the inner cylinder, the air being allowed to escape by a cock at the top, and great care being taken to have the vessel entirely filled and all the air driven out. The cocks being then closed, a current of warm water is allowed to flow through the space within the surrounding jacket, the temperature being gradually raised to the desired point, and maintained there as long as desired. The cylinder is at the same time slowly revolved, in order to distribute the heat throughout the mass of the liquid. When the sterilization is fully accomplished, the current of water is slowly cooled, until finally ice-water is passed through the jacket, thus removing all the heat from the sterilized liquid before the cylinder is opened. Under these conditions it is found that no change occurs in the condition of the material, and no taste of cooking or boiling, is imparted to it, it being impossible to distinguish milk thus sterilized from that which has not undergone the operation.

The principle of the method is explained in the following manner. The cylinder being entirely filled with the liquid, there is no room left for expansion. As the temperature rises, the attempted dilatation of the milk, being restrained by the confined space, causes a marked increase in pressure, which, for the temperatures of Pasteurization or sterilization, will reach five to six atmospheres. At such pressures the gaseous and aromatic constituents are

unable to separate from the liquid. After the sterilization has been accomplished the cooling under pressure causes these same constituents, which may have become temporarily dissociated, to be entirely reabsorbed, thus delivering the liquid in practically the same condition as before, except for the destruction of the germs by the heat.

It is believed that this apparatus will be of especial value in the production of wines, since it enables the fermentation to be arrested at any desired stage; and, when used in connection with microbiological investigations, it should be most valuable.

Electric Street Railways in Germany.

THE present status of the electric tramways in Germany is discussed by Dr. Gustav Rasch of Karlsruhe in the *Zeitschrift des Vereines deutscher Ingenieure.* The opinion is expressed that in locations where overhead wires are objectionable the storage battery offers greater advantages than underground conductors, both as regards first cost and economy of operation. The loss of time and labor incurred in charging batteries every trip is likely to be obviated by improvements which will enable one charge to operate a car for a day's run, the experiments made in the line of larger accumulator plates by the Hagen Accumulator works having been especially successful.

Notwithstanding the extensive use of overhead wires with return through the rails, there has as yet been no electrolytic action observed upon water- and gas-pipes in Germany, and, with currents of five hundred volts, but few accidents have occurred, and those in cases of peculiar negligence.

At the present time there are in Germany 227 miles of electric tramways in operation, with 560 motor cars and 450 trailers. The total electric mileage of Europe is now about 440 miles, so that Germany is far ahead of any other country. The following table shows the distribution of mileage by countries: Germany, 52 per cent.; France, 14 per cent.; England, 11 per cent.; Austro-Hungary, 6 per cent.; Switzerland, 5 per cent.; Belgium, 3 per cent.; Italy, 3 per cent.; Spain, 2 per cent.; Russia, 1 per cent.; Servia, 1 per cent.; Norway and Sweden, 1 per cent.; Roumania, 1 per cent.

Steam Superheating Apparatus.

THE revival of interest in superheated steam is giving renewed impetus to various devices for overcoming the defective points in apparatus for accomplishing moderate superheating with reasonable control of temperature.

In the *Oesterr. Zeitschr. f. Berg- u. Hüttenwesen* for February 27 is given an illustrated description of Hering's superheater, in which an attempt is made to obtain a uniform degree of superheating in a simple manner.

The superheating tubes, instead of being placed directly in the flue leading from the boiler, are placed in a sort of oven constructed above the boiler, and arranged so that, by manipulation of dampers, the discharge of gases from the flues can be caused partially or entirely to pass over the superheater.

When the boiler is steaming but moderately, and the flow of steam is small, the furnace gases can be entirely diverted from the superheater and sent to the chimney direct, the superheater tubes lying in a chamber of hot gases without danger of overheating; and from this degree of quiescence to the full intensity of the temperature of the discharge from the boiler-flues any desired degree can be obtained, merely by turning the regulating dampers which control the effective flue area.

Herr Hering shows two forms of superheater, both of which are familiar, one being composed of small bent tubes connected to manifolds similar to steam-heating coils in drying closets, and the other consisting of a system of annular chambers each formed by placing one tube within another; but it is evident that the sensible arrangement of the location of the superheater, with proper flues and dampers, may be applied to any form of apparatus, thus placing the superheating under much better control then when the tubes are placed directly in the flue.

A New Pyrometer.

THE increasing use of high temperatures in the arts, and the desirability of obtaining some simple, and at the same time reasonably accurate, apparatus for measuring such temperatures, is undoubtedly the cause of the advances made recently in different forms of pyrometers. The latest candidate for favor is the invention of M. Latarche, and is called by him the "Actinometric" pyrometer, a description of it being given in *La Revue Technique* for April 10, from which we condense the essential points.

Briefly, the apparatus depends upon the radiant heat emitted by the furnace or other source of heat to be measured, and consists of two thermometers so placed that the rays of heat may impinge upon the bulbs from such a distance that the actual temperatures indicated will fall within the limits of the ordinary scale. The bulb of one thermometer is silvered, and that of the other is blackened; hence there is a marked difference in their respective heat-absorbing capacities, and, therefore, the temperatures which they indicate will not be the same. From this difference the actual temperature of the radiating source of heat may be computed, the principle being analogous to the measurement of a distance by observing two angles at the extremities of a base of known length, the base in this case being the difference in the readings of the two thermometers. A third thermometer, the bulb of which is immersed in water so as to be screened from the action of the radiant heat, is used to give the actual temperature of the surrounding air, and, when a given set of instruments has once been calibrated, the scales may be so graduated that the furnace temperatures may be read off directly.

While the principle of the apparatus is undoubtedly sound, it is evidently adapted only to those cases in which the furnace may be exposed to the view, so to speak, of the instrument. There are, however, many locations in which the Latarche pyrometer will undoubtedly be of much service, and, since it is already in practical use in France, we may soon look for its application in this country as well.

Gas Motors for Tramways.

TRIALS, recently made in Germany, of the latest form of gas locomotive give interesting data as to the economy, speed, and general performance of this type of tramway motor. Details of the test are given in the *Mitt. d. Ver. f. d. Forderung des Local- u. Strassenbahnwesens* for February. The trial run was made between Dellnau and Oranienbaum, on the road from Dessau to Worlitz, the round trip being 17¼ miles, with a grade of 1 in 100 for one-half of the distance. The motor car, which was separate from the passenger carriage, contained a gas engine constructed by the Otto works at Deutz, and tanks for holding the gas, the total weight of the motor car being about eight tons. Including the motor, the total load hauled was about seventeen tons, and the speed ranged from six to fifteen miles per hour.

The total gas-consumption for the round trip of 17¼ miles, including the small consumption during the preliminary manipulation, was 345 cubic feet; at the price of 81 cents per 1,000 feet, the cost of the gas consumed by the trip was 28 cents. As a general result of the experiments, the consumption in regular service was shown to be from three-quarters to one cubic foot of gas per ton-mile. The capacity of the motor for gas and circulating water was sufficient for a trip of twenty-five miles; hence for longer lines either intermediate sources of gas-supply or greater tank-capacity must be provided. While the use of gas motors for tramway purposes is yet in its infancy, the economy is such as to render this application an inviting field for improvement in other respects, and, with the further introduction of cheap fuel-gas, the subject will become still more important.

The Regulation of Steam-Engines.

THE determination of the proper weight for fly-wheels usually involves the assumption of a certain coefficient of steadiness, called by different names in different textbooks, and varying between wide limits, according to the closeness of regulation required. The selection of this coefficient is generally left to the judgment and ex-

perience of the designer, and the otherwise simple mathematical relation which the weight of the wheel bears to the other elements of the engine is thus converted into a rather empirical formula. Prof. Moriz Kohn, in the *Zeitschr. des Oesterr. Arch. und Ing. Vereines* for March 12, discusses the other side of this question by determining the degree of irregularity which any given proportions will cause, thus enabling the choice of the proper coefficient of steadiness to be computed with a certain degree of precision.

The data used for the determination of the degree of unsteadiness are found in the indicator diagram, with which is combined the so-called inertia curve, first introduced into steam-engine computation by Mr. Charles T. Porter, and now so generally used in all high-speed engine investigations. By combining the forces acting in one direction with the resistances opposing their action, all the forces being reduced to a common point of rotation, the nature and degree of the inequalities to be overcome are very clearly shown, and the extent to which these can be regulated by a fly-wheel of given dimensions is then a matter of exact computation. Prof. Kohn's paper contains such diagrams, very carefully worked out, together with examples applied to irregular action such as is found in the gas engine, and an example of the application of the method to a compound engine. In the case of a projected engine the general type of indicator diagram may be used, as derived from the conditions under which the engine is intended to be operated.

German Stationary Boilers.

At the Nuremberg exhibition last year there were a number of steam boilers in use (now illustrated and described in the *Zeitschr. des Vereines deutscher Ingenieure* for March 20), which are interesting as examples of a type formerly much in use in this country and known as the "double-deck" boiler.

While in the main these boilers are of the same general construction as the American generators, yet there are important differences. The old "double-deck" boiler consisted of a lower shell, generally fired beneath, and filled with tubes in the same manner as an ordinary tubular boiler, while above it, and connected by two or more necks, was another shell, about which the gases played on their way to the chimney. The water-level being carried in the upper shell, there was a large extent of efficient heating surface, and the arrangement gave in many cases high evaporative results.

The German boilers exhibited at Nuremberg are internally fired, the lower shell, which is from 7 to 10 feet in diameter, having one or two corrugated furnaces, one example having also Galloway tubes in the rear of the furnace. The upper shell contains a large number of small tubes, through which the gases pass, returning over the top to the chimney.

In these boilers, however, each shell has its own independent water-level, the single connection passing from the steam space of the lower shell through the water space of the upper shell, and the steam from both being taken off through an upper dome. By having a single connection all strains from unequal expansion of the two shells are avoided, this having been found to be a prolific source of danger in the old construction; and, as each shell has its own feed connection and there is no connection between them below the water lines, each has its own independent circulation.

Tests of a boiler of this construction, built by the *Maschinenbau-Aktien-Gesellschaft* of Nuremberg, formerly Klett & Co., showed an evaporation of 2.66 pounds of water per square foot of heating surface per hour from a temperature of 111° F., and a pound of coal containing 13,300 heat units gave an evaporation equivalent to 9.34 pounds of water from 32° F., evaporated at 212° F., corresponding to an efficiency of 80 per cent.

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CONSTRUCTION AND DESIGN.

ARCHES.

Note on the Strength of Arches between Rolled Beams. (Ein Beitrag zur Reform der Gewölbstärken zwischen Walzträgern) Discusses the twisting action which the arches exert upon the beams and the risks which are incurred by neglecting it. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 2, 1897. No. 12717. 30 cts.

AUSTRIA.

Austrian Architecture. (Wiener Bauten Album.) Plates and descriptive text of buildings in Graz and Vienna. Photogravures. 1500 w. and 5 plates. Wiener Bauindustrie Zeitung—April 1, 1897. No. 12784. 45 cts.

BANK Building.

The Most Unique and Complete Banking Building in America. Illustrated detailed description of the Illinois Trust and Savings Bank, in Chicago. 10000 w. In Arch—May, 1897. No. 13156. 45 cts.

BARRACKS.

Knockdown and Portable Dwellings. (Ueber Zerlegbare und Transportable Wohnhäuser.) Devoted chiefly to the construction of portable barracks for military use. 5000 w. and 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 23, 1897. No. 12722. 30 cts.

CHURCHES.

Double-aisled Churches (Ueber Zweischiffige Kirchenbauten.) A discussion of church design with wide nave and aisle on one side, with illustrations of buildings so altered. 4500 w. Zeitschr. d Oesterr Ing u. Arch Ver—April 30, 1897. No. 12724. 30 cts.

Village Churches. G. G. Scott. Discusses the importance of the site, the tower, the chancel, chancel screens, &c. 6000 w. Arch, Lond —May 14, 1897. No. 13102. 30 cts.

COLUMN.

See Civil Engineering, Miscellany.

CONGRESSIONAL Library.

The New Library of Congress. Montgomery Schuyler. Interesting illustrated description of the architectural features. 7000 w. Scribner's Mag—June, 1897. No. 13108. 30 cts.

See same title under Heating and Ventilation.

PAINTING.

The Painting of Metallic Structures. Comments on information given by A. H. Sabin, formerly professor of chemistry in the University of Vermont, on the constitution of paints, and the results of important experiments. 1500 w. Engng—May 14, 1897. No. 13079. 30 cts.

EXPOSITION.

The World's Columbian Exposition. Arthur Peabody. A study of the constructive problem and its value as a criterion. The general design, buildings, construction, materials and methods. 8500 w. Technograph—No. XI. No. 13033. 45 cts.

FIREPROOF Construction.

Fireproof Building Construction in the Pittsburg, Pa., Fire. Account of the origin and progress of the fire, the burned buildings, and views showing the effects on fireproof construction, and editorial containing suggestions to engineers and architects. 6000 w. Eng News—May 20, 1897. No. 12998. 15 cts.

Fireproofing Tests. Describes an interesting test at the proving ground at 68th St. and Avenue A, New York, conducted after the requirements of the New York Dept. of Buildings. The arched or flat-domed floor, built after Mr. Guastavino's method of cohesive construction, was submitted to a test of unusual severity. 1600 w. Am Arch—May 8, 1897. No. 12826. 15 cts.

Official Test of Fireproof Floor Construction Systems. Report of the test of the "Metropolitan" system. Ill. 1800 w. Eng Rec—May 29, 1897. No. 13184. 15 cts.

An Instructive Fire in Pittsburg, Pa. An illustrated account of the large fire in Pittsburg, interesting as giving an opportunity of judging of the value of modern methods of fireproofing. 2200 w. Eng Rec—May 22, 1897. No. 13084. 15 cts.

FLOORS.

Floors. Fred T. Hodgson. Editorial on the requisites of a good floor, and how to construct one; bridging, causes of weakness, &c. 1400 w. Nat Build—April, 1897. Serial. 1st part. No. 12821. 30 cts.

FOUNDATIONS.

Eccentric Loads on Foundations. F. L. Douglas. The purpose of the article is to show an easy method for obtaining the maximum pressure under the heel of the footing, and applies to all cases where footings rest directly upon the earth, and also where grillage beams are used to distribute the loads over greater areas, and when slightly modified may be used in obtaining the proportion of total load carried by each of the several lower grillage beams when the loads are not symmetrically placed. 700 w. Eng News—May 20, 1897. No. 12994. 15 cts.

FRAMEWORK.

Notes on Framework in Space. (Bemerkungen über Räumliches Fachwerk.) A geometrical investigation of some of the points involved in the design of trussed domes, conical roofs, and framed structures in three dimensions. 5000 w. Zeitsch d Ver Deutscher Ing—April 24, 1897. No. 12709. 30 cts.

HOSPITALS.

The Construction of Hospitals. William Henman. Read before the Liverpool Archt. Soc. Deals principally with the design of large town hospitals, discussing all important details. Ill. 5800 w. Jour Roy Inst of Brit Archts—May 6, 1897. No. 13222. 30 cts.

IMITATION.

Imitation in Architecture. A. C. Munoz. Published in the Philadelphia *Times*, and reproduced as an excellent example of the general direction pursued by modern thought in regard

to present-day architectural design. 3400 w. In Arch—May, 1897. No. 13158. 45 cts.

MASONRY.

Broken Ashlar Masonry. W. W. Beach. Illustrations and discussion of the possibilities of this form of masonry. 1400 w. Technograph. No. XI. No. 13035. 45 cts.

NORTHAMPTON, England.

The Architecture of Our Large Provincial Towns Illustrated description of the architecture of Northampton, with historical accounts of some of the buildings. 6600 w. Builder—April 24, 1897. No. 12620. 30 cts.

OBSERVATORY.

The Observatory Tower of Stolberg. (Der Aussichtsturm auf der Josephshöhe bei Stolberg am Harz.) A handsome iron lookout tower, 118 feet high. The top is in the form of a horizontal Greek cross with four large projecting balconies. 1200 w. Zeitschr d Ver Deutscher Ing—April 10, 1897. No. 12704. 30 cts.

ROTARY Buildings.

Portable and Rotary Buildings. (Edifice Démontable Rotatif.) Detailed description of the rotating house which it is proposed to construct for the exposition of 1900. 2500 w. La Revue Technique—April 25, 1897. No. 12736. 45 cts.

STYLE.

The Fundamentals of the Development of Style. Peter B. Wight. An address before the Chicago Architectural Club. A talk on what the author considers necessary for the foundation of style. 4500 w. In Arch—May, 1897. No. 13157. 45 cts.

TALL BUILDINGS.

Engineering Problems of the Tall Building. Charles O. Brown. Reviewing the leading features adopted in the erection of "Skyscrapers." Ill. 3800 w. Eng Mag—June, 1897. No. 13264. 30 cts.

THEATRE.

The Reconstruction of the Vienna Burgtheatre. (Die Reconstruction des Burgtheatres.) A criticism of the numerous defects of the building, by Prof. Prokop, with suggestions for its interior reconstruction, and incidentally many useful notes on theatre construction in general. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—May 14, 1897. No. 12729. 30 cts.

VAULTS.

Modern Vault Construction. John Beverley Robinson. Illustrated detailed description of the requirements and construction of vaults, attacks on vaults, &c. 4400 w. Arch Rec—April-June, 1897. No. 12623. 30 cts.

WALLS.

Walls and Ceilings of Hollow Bricks of Cement and Plaster. (Wände und Decken aus Cement- und Gyps-Hohltafeln.) A review of Continental practice, with data concerning loads and sustaining power. Two articles. 5000 w. Wiener Bauindustrie Zeitung—April 15 & 22, 1897. No. 12786. 45 cts. each.

WINDOWS.

Decorative Windows in England and America. Russell Sturgis. Interesting review of a book by Henry Holiday entitled "Stained Glass as an Art." 5000 w. Arch Rec—April-June, 1897. No. 12625. 30 cts.

WOODEN Houses.

Wooden Houses in Switzerland. Jean Schopfer. An interesting illustrated description of the exhibition of Swiss châlets of various epochs, at the Geneva National Exposition of 1896 The "Swiss Village" was arranged on historical lines, each house exists, or did exist, in reality. 3200 w. Arch Rec—April-June, 1897. No. 12622. 30 cts.

WORKMEN'S Homes.

Improved Housing for the Poor. Ella Hood Cooper. Suggests a plan by which many of the evils of the present system of tenement house construction may be mitigated. 2000 w. Gunton's Mag-June, 1897. No. 13252. 30 cts.

Uninhabitable Dwellings. Hugh R. Jones. Extract from a paper read at meeting of the Sanitary Inspectors of Carnarvonshire and District. Discusses the problem of housing satisfactorily the "wage-earning" classes. 3500 w. San Rec—April 30, 1897. No. 12802. 30 cts.

ZURICH.

Buildings for the Old Tonhalle Place in Zurich. (Bebauungsplan des Areals der Alten Tonhalle in Zurich.) Handsomely illustrated account of Prof. Bluntschli's admirable design for the occupation of a most valuable building location. 2500 w. 1 plate. Schweizerische Bauzeitung—April 17, 1897No. 12749. 30 cts.

HEATING AND VENTILATION.

CONGRESSIONAL Library.

Heating and Ventilation of the Congressional Library. Part first gives an illustrated general description, floor plans, and distribution of flow and return pipes. 2400 w. Eng Rec—May 1, 1897. No. 12599. 15 cts.

CENTRAL Station.

Central Station Heating System at Fredonia, N. Y. Illustrated description of the heating of a number of buildings from the engines of the electric railway plant, using the exhaust steam, and in extreme weather by live steam injected from same plant. 1200 w. Heat & Ven—May 15, 1897. No. 12970. 15 cts.

SCHOOL.

Heating, Ventilating and Plumbing the Grammar School at Saugus, Mass. Illustrated detailed description. 2300 w. Met Work—May 8, 1897. No. 12614. 15 cts.

Heating and Ventilation of Public School No. 14, Erie, Pa. Floor plans and description clearly show the arrangement of the system. 600 w. Heat & Ven—May 15, 1897. No. 12971. 15 cts.

Notes on Heating of Schools. (Einiges über Schulheizung.) Discussing the various methods employed in Germany, including stoves, steam, hot water and hot air. Three articles. 10,000 w. Gesundheits Ingenieur—April 15, 30, May 15, 1897. No. 12777. 60 cts.

STEAM Heating.

Hints on Steam-Heating. M. O. Kasson. Calls attention to loss of heat from position of radiators, or from covering tops of radiators, and various other practices. 2400 w. Sta Eng —May, 1897. No. 12656. 15 cts.

Laying up Steam-Heating Plants. W. H. Wakeman. Caring for the boilers and appliances which must remain out of use. 800 w.

Am Mach—May 6, 1897. No. 12662. 15 cts.

Some Points on Steam Heating. F. A. Camp. From a paper read before the Minnesota Archt. Assn. Explains what steam is and how made, the importance of a good draft, and of a good circulation. 1800 w. San Plumb—May 1, 1897. No. 12638. 15 cts.

LANDSCAPE GARDENING.

FLORICULTURE.

The Hardy Flower Garden. A. Herrington. Read at meeting of the New Jersey Floricultural Soc. Extract giving suggestions for a garden that shall bloom with the advancing seasons, with lessons from nature. 1800 w. Gar & For—May 19, 1897. No. 12935. 15 cts.

LANDSCAPE-Gardening.

Art and Nature in Landscape-gardening. Editorial on the importance of obtaining the counsel of a landscape-gardener of recognized standing, rather than attempting to work out one's own ideas. 1200 w. Gar & For—May 19, 1897. No. 12934. 15 cts.

PARKS.

The True Purpose of a Large Public Park. John C. Olmsted. Extract from a paper read before the Park and Outdoor Art Assn. of Louisville, Ky. Considers the purpose is to provide for city dwellers an opportunity to enjoy natural scenery and find relief from the nervous strain of city life. Opposes anything that interferes with this purpose. 2200 w. Gar & For—June 2, 1897. No. 13221. 15 cts.

The Way to Make Parks Attractive. Editorial suggestions as to arrangement of flowering shrubs, small trees, &c. 1000 w. Gar & For—May 26, 1897. No. 13116. 15 cts.

SCHOOL Gardens.

School Gardens and School Grounds. Editorial suggested by a leaflet sent out recently by the Cornell Experiment Station inviting each of the school children to plant a little garden of sweet peas and China asters. The work in this line in Germany is cited. 1300 w. Gar & For—May 5, 1897. No. 12631. 15 cts.

PLUMBING AND GASFITTING.

DOMESTIC Plumbing.

Plumbing and House Drainage. Reuben S. Bemis. The importance of this feature in the construction of homes, the dangers of neglect, faults in plumbing of dwellings, with important suggestions. 2700 w. San Plumb—May 1, 1897. No. 12639. 15 cts.

Plumbing, Heating and Ventilating of Claus Spreckels' Mansion in San Francisco, Cal. Description of scientific sanitary improvements in one of the beautiful homes of that city. 3800 w. Dom Engng—May, 1897. No. 13107. 30 cts.

FIRECLAY.

Fireclay Manufacturers. W. H. Allen. Read before the Northern Architectural Assn. Describes the process of manufacture of sanitary pipes and specialties, glazed bricks, scullery sinks, white channel bends, closets, &c. 3300 w. Arch, Lond—April 30, 1897. No. 12810. 30 cts.

PLUMBERS.

The Architect in his Relation to the Plumber. W. J. Burroughs. The importance of the plumber's work, the need of harmony between plumber and architect, and the need of wise legislation. 2500 w. Can Arch—May, 1897. No. 13091. 30 cts.

PLUMBING.

Full Course of Technical Instruction for Plumbers. A series of articles by a registered teacher and first-honors silver-medallist. Part first consists of introduction, and a consideration of duodecimals and mensuration. 2500 w. Dom Engng—May, 1897. Serial. 1st part. No. 13105. 30 cts.

SANITARY Appliances.

Modern Sanitary Appliances for Interior of Dwelling Houses. W. J. Wells. Considers closets, baths, lavatories, cisterns and sinks, with the supplies and wastes from same. 3500 w. Dom Engng—May, 1897. Serial. 1st part. No. 13106. 30 cts.

The Rise and Progress of Sanitary Plumbing. John Glaister. Inaugural address in the Glasgow and West of Scotland Technical College. Part first hastily reviews the early history of plumbing, and gives some account of the history of water-supply in Glasgow. 3000 w. Dom Engng—May, 1897. Serial. 1st part. No. 13104. 30 cts.

MISCELLANY.

ANCIENT Cities.

The Ancient Cities of the Old World. Cyrus K. Porter. The subject is confined to the architecture of Egypt, Assyria and Chaldea as studied in the ruins, with some account of their important cities. 6000 w. Stone—May, 1897. No. 13026. 30 cts.

ARCHITECTURE.

Natural Selection in Architecture. C. H. Blackall. A discussion of the methods of arriving at desired results in architecture. 2500 w. Technograph. No. XI. No. 13028. 45 cts.

The Works of Cady, Berg & Lee. Montgomery Schuyler. Illustrated description of important work by architects named, with brief biographical sketches, and criticism and comment. 8500 w. Arch Rec—April-June, 1897. No. 12626. 30 cts.

BOSTON.

Recent Boston Architecture. Albert Winslow Cobb. The first part is introductory, and also considers the buildings at the memorial and commercial center. Ill. 2000 w. Arch & Build—May 15, 1897. Serial. 1st part. No. 12888. 15 cts.

BRICK and Terra-Cotta.

Brick and Terra-Cotta at the League Exhibition. An illustrated review of the work exhibited at the annual exhibition of the Architectural League of New York. 2200w. Br Build—April, 1897. Serial. 1st part. No. 12621. 30 cts.

BUILDING Stones.

The Building Stones of New England. William Beals, Jr. Illustrated description of the varieties found in each state. 6000 w. Stone—May, 1897. Serial. 1st part. No. 13025. 30 cts.

COLOR.

Color in its Relation to Architecture. Elmer Ellsworth Garnsey. An interesting article presenting the value of color in architecture, the advantage of the study of harmony in color, and many suggestions. 3300 w. Br Build—May, 1897. 30 cts.

FORMAL and Informal Treatment.

The Formal and Informal in Architecture. Discusses the symmetry that distinguishes picturesque beauty from ordinary beauty and illustrates the writer's views. 3000 w. Arch, Lond—April 30, 1897. Serial. 1st part. No. 12811. 30 cts.

HERALDRY.

Heraldry of the Renaissance in England. J. Alfred Gotch. Read at general meeting of the Roy. Inst. of Brit. Archts. A study of the subject from the decorative side. The causes of deterioration in heraldic drawing are reviewed and its uses in historical research. Illustrations and discussion. 5000 w. Jour Roy Inst of Brit Archts—April 1, 1897. No. 12635. 45 cts.

HOUSES.

Houses for Homes. Considers how best to house the happy home. Makes suggestions for the planning of a city house. 1800 w. Nat Build—May, 1897. No. 12918. 30 cts.

LOGARITHMS.

Graphical Logarithmic Tables. (Graphische Logarithmentafeln.) A discussion of the advanages of substituting logarithmic scales in the form of tables for the usual numerical tables. 1200 w. Zeitschr d Oesterr Ing u Arch Ver —May 7, 1897. No. 12726. 30 cts.

MEDIEVAL Architecture.

A Discovery of Horizontal Curves in Medieval Italian Architecture. William H. Goodyear. Describes facts established by the Brooklyn Inst. Survey of 1895, of the discovery of the refinement of curving horizontal lines, generally supposed to be restricted to the temples of the Greeks, in the churches and cloisters of Italy. Ill. 7800 w. Arch Rec—April-June, 1897. Serial. 1st part. No. 12624. 30 cts.

PARIS Fire.

The Lesson of the Paris Fire. Points out the great risk of temporary buildings, and the danger of using rooms unsuited in plan for bazaars, or public entertainments. 1600 w. Builder—May 8, 1897. No. 12945. 30 cts.

The Fire at the Paris Bazaar. Additional information of this catastrophe, with illustrations of site, buildings, plans, &c. 1800 w. Engng —May 14, 1897. No. 13077. 30 cts.

PARTHENON.

How a Riddle of the Parthenon was Unraveled. Eugene P. Andrews. Describes the method of unraveling the riddle of the nail-holes in the architrave of the east front of the Parthenon. Ill. 5500 w. Century Mag—June, 1897. No. 13196. 45 cts.

The Parthenon and the Earthquake of 1894. F. C. Penrose. Read at meeting of Royal Inst. of British Archs. Abstract of paper and discussion. 2000 w. Arch, Lond—May 21, 1897. No. 13183. 30 cts.

RESTORATION.

A Note concerning Correct Restoration. (Ein Wort zur Güte über Restaurien.) Discusses the injuries often wrought to old buildings, monuments, &c., under the guise of restoration, and makes a plea for greater consistency and accuracy. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—April, 1897. No. 12752. 45 cts.

SCHOOL of Architecture.

The Summer School of Architecture for 1896 in Southern England, Normandy, and Touraine. Eleazer B. Homer. Interesting account, beautifully illustrated, of the excursion of the M. I. T. Summer School of Architecture, including about one thousand miles of bicycle travel in Europe. 8500 w. Tech Quar—March, 1897. No. 12908. 75 cts.

SKETCHES.

Architectural Rendering in Pen and Ink. D. A. Gregg. Hints, with illustrations, of this class of work. 1800 w. Br Build—May, 1897. No. 13142. 30 cts.

TALL Buildings.

Weighing of Tall Buildings. Theodore Waters. Finding the exact gravity of huge masses of iron and stone, every bolt, bar, and pane of glass carefully considered; the weight of tenants and casual visitors and even paint and carpets determined. 1800 w. So Arch—May, 1897. No. 12615. 30 cts.

WESTMINSTER Abbey.

The Story of an Illustrious Abbey. A. T. Taylor. Paper presented before the Province of Quebec Assn. of Architects. A very interesting account of Westminster Abbey. 9500 w. Can Arch—May, 1897. No. 13090. 30 cts.

WIND-PRESSURE.

Wind Pressure in St. Louis Tornado. Julius Baier. Facts ascertained from the inspection of the buildings, with general study of the subject. 3200 w. In Arch—May, 1897. No. 13159. 45 cts.

CIVIL ENGINEERING.

BRIDGES.

BRIDGE.

See Railroad Affairs, Maintenance of Way.

CAISSONS.

The East-River Bridge Caissons. Information of the construction of these caissons, one of which is ready to launch. 700 w. Eng Rec—May 15, 1897. No. 12948. 15 cts.

COFFER-DAM.

Deep Coffer-Dam Construction for Bridge Piers, Portland and Rumford Falls R. R. Illustrated description of two coffer-dams built against an unusual head of water and possessing structural features of interest. 800 w. Eng

News—May 27, 1897. No. 13138. 15 cts.

DON.

Bridge Over the River Don. Drawings of the principal members, etc., with description, of a popular type of bridge. 900 w. Eng, Lond—May 21, 1897. No. 13211. 30 cts.

EAST-RIVER Bridges.

Foundations for the Brooklyn Tower of the New East-River Bridge. Gives drawings and descriptions of this work, taken from the official plans and specifications. 2800 w. Eng News—May 27, 1897. No. 13139. 15 cts.

The New York and Long Island Bridge, New York City. Illustrated description of the great steel cantilever bridge by which the Long Is. R. R. Co. expects in due time to run its trains into New York City. 1600 w. Sci Am—May 8, 1897. No. 12643. 15 cts.

FRANCIS-JOSEPH.

The New Francis-Joseph Bridge. The fundamental system of the structure is explained and illustrations and description of the architectural features. The whole appearance of the structure is said to be striking and elegant and to add to the charms of Buda-Pesth. 2200 w. Eng, Lond—May 14, 1897. No. 13073. 30 cts.

LIFT Bridge.

Lift Bridge at Milwaukee. Illustrated description of the Huron St. bridge. 1800 w. Ry Rev—May 15, 1897. No. 12950. 15 cts.

NEWARK.

The Fourth-Street Bridge, Newark. Illustrated description of a heavy solid-floor steel highway drawbridge and approaches to be constructed across the Passaic River. 2000 w. Eng Rec—May 1, 1897. No. 12598. 15 cts.

PAINTING.

See Architecture and Building, Construction and Design.

ROCK Island.

Building the Draw Span of the New Rock Island Bridge. An account of the accident by which this bridge was wrecked by the ice when in process of building, and of its rapid reconstruction. 3400 w. R R Gaz—May 28, 1897. No. 13150. 15 cts.

STRESSES.

See Same title under Mining and Metallurgy, Iron and Steel.

TESTING.

Recent Tests of Bridge Members. J. E. Greiner. Discusses a number of tension tests on bridge members, other than eye-bars, made by the author. These tests are in a channel outside of the usual run, and the results obtained furnish information of interest and value. Ill. 6000 w. Pro Am Soc of Civ Engs—May, 1897. No. 13126. 75 cts.

VIADUCT.

The Mussy Viaduct; Paris, Lyons, and Mediterranean Railway. Illustrates and describes several interesting features. 1100 w. Engng—April 30, 1897. No. 12684. 30 cts.

CANALS, RIVERS AND HARBORS.

BLOCK-SETTING.

40-Ton Block-Setting "Titan." Illustrated description of a machine to be used in the construction of the harbor works at Vera Cruz, Mexico. 1200 w. Engng—May 14, 1897. No. 13076. 30 cts.

BOSTON Harbor.

Boston's Harbor Defects. From the N. Y. *Times*. Development of the ocean trade of that port retarded by shoal water. 1100 w. Sea—June 3, 1897. No. 13247. 15 cts.

CONCRETE.

Concrete as Made on the Trent Canal. H. F. Greenwood. A brief description of the methods used and the precautions taken in constructing some of the works named. Ill. 2500 w. Can. Arch—May, 1897. No. 13089. 30 cts.

CONCRETE Machinery.

Concrete Machinery on the Chicago Drainage Canal. Illustrated description of the machines used on Sections 14 and 15, in building the retaining walls. 1200 w. Eng Rec—May 22, 1897. No. 13082. 15 cts.

DAM.

A New Dam at Minneapolis. H. M. F. Dahl, A general description of the dam built below the falls for the purpose of utilizing the power. Ill. 1700 w. Eng's Year Book, Univ. of Minn, 1897. No. 13010. 45 cts.

Effects of Mississippi River Floods on the New St. Anthony Falls Dam at Minneapolis. Horace B. Hudson. The conditions under which the break occurred are stated, and illustrations showing the appearance of the dam. 700 w. Eng News—May 13, 1897. No. 12877. 15 cts.

DUNKIRK.

Port of Dunkirk.—New Deep-Water Lock. An illustrated account of this lock, which had to be constructed in the immediate neighborhood of existing works on a bed of sand, and under great difficulties. 1800 w. Eng, Lond—May 14, 1897. No. 13072. 30 cts.

FLOODS.

See Railroad Affairs, Miscellany.

Suggestions for the Control of Mississippi River Floods. Samuel McElroy. Suggestions in the line of relief submitted by an expert in various flood cases. 900 w. Eng News—May 20, 1897. No. 12997. 15 cts.

GROYNES.

Groynes and Sea-Coast Defenses. A. T. Walmisley. Read before the Inst. of Municipal and Civil Engs. Maintenance of cliff faces, the retention of a fore-shore, and such works of protection as are necessary to secure the advantages of a seaport. 2500 w. Ind & Ir—April 30, 1897. No. 12694. 30 cts.

HARBOR.

The Conversion of the Danube Canal at Vienna into a Dock and Winter Harbor. (Ueber die Arbeiten zur Umwandlung des Wiener Donaucanals in einen Handels- und Winterhafen.) An elaborately illustrated account of these very important harbor improvements. Two plates of details and numerous illustrations. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—April 2 and 9, 1897. No. 12715. 60 cts.

The New Waterways and Land Reclamation at Seattle, Wash. Extracts from a letter of Mr. Eugene Semple, giving interesting information, with editorial comment, calling attention to necessary precautions in this class of work. 2300 w. Eng News—May 27, 1897. No. 13140. 15 cts.

LEVEES.

A New Levee System. Guy M. Walker. Outlines a plan for protecting the banks of the Mississippi, and the advantages of permanent protection. 2000 w. State's Duty—May, 1897. No. 12676. 15 cts.

PIER.

The Public Pier of Panillac. Illustrated description of a fine piece of engineering work which has made it possible for Bordeaux to stand third in rank among the great commercial ports of France. 1800 w. Sci Am Sup—May 15, 1897. No. 12857. 15 cts.

PROPULSION.

See Mechanical Engineering, Power and Transmission.

STETTIN.

The Harbor of Stettin and its Water Communication with the Sea and the Interior. (Ueber die Hafenanlagen Stettins und dessen Wasserverbindungen mit dem Meere und dem Binnenlande.) An account of the important harbor improvements of Stettin, by means of which it is expected to compete with Hamburg and Bremen. Three articles. 4500 w. Deutsche Bauzeitung—April 24, May 1 & 8, 1897. No. 12788. 30 cts. each.

WATERWAYS.

Deep Waterways from the Great Lakes to the Sea. Allan Ross Davis. A review of the Trent Canal project. Ill. 3800 w. Eng Mag—June, 1897. No. 13261. 30 cts.

IRRIGATION.

IRRIGATION.

Irrigation. Guy M. Walker. Reviews the history of irrigation in ancient and oriental countries, and calls attention to its importance in this country, offering suggestions for the raising of the needed funds. 2000 w. State's Duty—June, 1897. No. 13244. 15 cts.

Irrigation in North-west Canada. From the Annual Report of the Dept. of the Interior for 1895. Information of the area of arid region in Canada. 900 w. Ind Engng—April 10, 1887. Serial. 1st part. No. 12842. 45 cts.

MISCELLANY.

AQUEDUCT.

The Construction of the Nussdorf Aqueduct. (Ueber die Art der Ausführung der Alimentations-Canäle bei Nussdorf.) Describing especially the construction of the inverted siphon under the Elbe. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—April 9, 1897. No. 12718. 30 cts.

COLUMN.

The Theory of the Ideal Column. Henry S. Prichard. An analysis of the theory resulting from the application of the ordinary assumptions of flexure to the case of straight columns, with constant cross-section, centrally loaded. The conclusions favor the use of the ordinary empirical formulas. 3000 w. Eng News—May 6, 1897. No. 12679. 15 cts.

The Theory of the Ideal Column. Papers by Messrs. Merriman, Dubois, and Johnson prepared as comments upon the paper with the above title by Henry S. Prichard. 6400 w. Eng News—May 20, 1897. No. 12996. 15 cts.

CONCRETE.

See same title under Canals, Rivers and Harbors.

DAM.

See same title under Municipal Engineering, Water Supply.

ICE Gorge.

Ice Gorge Blasting at Niepolomice. (Die Eissprengung bei Niepolomice.) Describing the effective use of dynamite to remove ice gorges in the Vistula. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1897. No. 12751. 45 cts.

MASONRY.

See same title under Architecture, Construction and Design.

PAINTING Iron Structures.

See Architecture and Building, Construction and Design.

RACE Tracks.

Race Tracks. How to Build and Repair Them. W. R. Hoag. Discusses the selection of the site, best material for the track, laying out the track, drainage and resurfacing. 2300 w. Eng's Year Book. Univ of Minn—1897. No. 13011. 45 cts.

ROADS.

Drainage of Country Roads. E. A. Whitman. Discusses surface and sub-surface drainage, drains, culverts, &c. 2600 w. Jour Assn of Engng Soc—April, 1897. No. 13020. 30 cts.

European Roads. William R. Hoag. Some reference is made to early road-building, which was begun in England and followed by other countries. The questions of expense and construction are briefly considered. 3000 w. Jour Assn of Engng Soc—April, 1897. No. 13019. 30 cts.

State Roads of Massachusetts. Albert A. Pope. Some information of the work already accomplished in this state. 1500 w. State's Duty—May, 1897. No. 12675. 15 cts.

SOUTH AMERICA.

Engineering in South America. W. C. Weeks. Experiences during several months of exploration of the Orinoco Delta in the Republic of Venezuela. Ill. 2500 w. Eng's Year Book, Univ of Minn—1897. No. 13001. 45 cts.

TOPOGRAPHICAL Surveys.

Topographical Surveys—Methods Used on the Vanderbilt Estate at Biltmore, N. C. John L. Howard. The problem to be solved is stated and the method used described. 2300 w. Jour Assn of Engng Soc—April, 1897. No. 13018. 30 cts.

Topographical Surveys of the Metropolitan Park Reservations of Massachusetts. Henry F. Bryant. Interesting description of the work, with maps. 4800 w. Jour Assn of Engng Soc—April, 1897. No. 13017. 30 cts.

TELEMETRY.

The Opera Glass Telemeter. (La Jumelle Stéréoscopique Stadia-Télémètre.) The relative displacement of the images by means of a combination of prisms enables the distance to be determined directly. Especially intended for military use. 1500 w. La Revue Technique—April 25, 1897. No. 12738. 45 cts.

TUNNEL.

Construction and Cost of the Jungfrau Tunnel. (Ueber den Bau und die Kosten des Jungfraubahn-Tunnelo.) A discussion of the difficulties to be encountered in this bold and interesting piece of Alpine railroading. 2000 w. Schweizerische Bauzeitung—April 10, 1897. No. 12747. 30 cts.

The Blackwall Tunnel. Illustrated description of this interesting engineering work recently completed and opened. 4500 w. Eng, Lond—May 21, 1897. No. 13209. 30 cts.

The Simplon Tunnel. A glance at the various problems, physical, mechanical and economical, that have had to be solved. 1800 w. Nature—April 29, 1897. No. 12699. 30 cts.

The Simplon Tunnel. The latest project for tunneling the Simplon, and present status of the enterprise, as given by M. Jules Michel, in the "Revue Generale des Chemins de Fer." Map and Ills. 1600 w. Eng News—May 27, 1897. No. 13137. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BRITISH Competition.

Competition with British Trade Abroad. Memorandum based on information contained in official reports. Calls attention to points of importance to manufacturers and exporters, if they are to hold their share of trade in foreign countries. 4000 w. Bd of Trd Jour—May, 1897. No. 13128. 30 cts.

CANADA.

Our Trade Relations With Canada. John W. Russell. Discusses the desirability and probability of improved trade relations between the United States and Canada. 3000 w. N Am Rev—June, 1897. No. 13219. 45 cts.

CUSTOMS.

Customs Regulations in Brazilian Ports. Instructions to shippers and captains trading with Brazil. 1500 w. Bd of Trd Jour—May, 1897. No. 13129. 30 cts.

INDIA-RUBBER.

The India-Rubber Industry in Europe. Information of interest from various points. 2200 w. Ind Rub Wld—May 10, 1897. No. 12681. 45 cts.

IRON Trade.

The Competitive Basis and Conditions of the American Iron Trade. Franklin Hilton. Read before the annual meeting of the British Iron Trade Assn. Considers iron ore supplies, coal and coke supplies, railway transport, lake, canal and river transport, labor, equipment, royalties, the Carnegie Co.—with conclusions. 4200 w. Ir & Coal Trds Rev—May 21, 1897. No. 13161. 30 cts.

JAPAN.

Industrial and Commercial Conditions in Japan. Editorial discussion of some of the conditions and problems of the industrial movements going on in Japan. 2200 w. Engng—May 7, 1897. No. 12900. 30 cts.

PRICES.

Comparative Prices of 108 Staple Articles. Raw and Manufactured Products, Produce, Cattle and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from July 1, 1892 to May 1, 1897, Covering the Period of Recent Extreme Depression. Tabulated statement. 2500 w. Bradstreet's—May 22, 1897. No. 13045. 15 cts.

TARIFF.

Dutiable and Free Lists of the New Canadian Tariff. The list as formally announced April 23, and that went into effect immediately. 2000 w. Bul of Am Ir & St Inst—May 10, 1897. No. 12804. 15 cts.

Tariff Changes and Customs Regulations. Belgium, France, French Guiana, Austria, Austria-Hungary, Roumania, Bulgaria, United States, United States of Colombia, Venezuela, Ecuador, Cyprus, Lagos, Cape of Good Hope. 5000 w. Bd of Trd Jour—May, 1897. No. 13130. 30 cts.

YANGTZE KIANG.

The Region of the Yangtze Kiang. A report aiming to give an accurate account of the trade of this region. A description of the river, and important ports is given and a very interesting account of the industries, trade, &c. 8500 w. Cons Repts—May, 1897. No. 13040. 45 cts.

CURRENCY AND FINANCE.

CHINA.

Silver in China, and Its Relation to Chinese Copper Coinage. Talcott Williams. Reviews the history of silver as a currency, and shows that the same laws control and operate in the working of currency in China as are felt elsewhere. 6800 w. An Am Acad—May, 1897. No. 12909. $1.00.

COINAGE.

Theory and History of Coinage. From the Annual Report of the Director of the Mint. A survey of the coinage in various countries, their values, and related information. 7500 w. Bankers Mag, N. Y.—May, 1897. Serial, 1st part. No. 12871. 45 cts.

FINANCE.

The Financial Relations Between Ireland and Great Britain. L. H. Courtney. A statement of the case and suggestions for securing justice. 6300 w. Contemporary Rev—May, 1897. No. 12872. 45 cts.

JAPAN.

Japanese Currency and Industry. Editorial on the recent legislation in regard to the currency and information given in report of Mr. Jamieson, the Consul in Shanghai. 1800 w. Engng—May 21, 1897. No. 13153. 30 cts.

GOVERNMENT CONTROL.

COMMERCE.

Congress Should Regulate All Our Commerce. Howard S. Abbott. Condensed paper read at National Convention of RR. Commissioners, at St. Louis. 1900 w. RR Gaz—May 21, 1897. No. 12984. 15 cts.

DIFFERENTIALS.

The Outports in the Differential Rate Case.

Report of the Philadelphia meeting of the commission, which was mainly devoted to the exposition of views of shippers and grain dealers of that city and Baltimore. 1100 w. Bradstreet's—May 15, 1895. No. 12887. 15 cts.

FACTORY Acts.

India-Rubber Works and the Factory Acts. Explains why the order has been issued, and combatting the idea that india-rubber working generally is an unhealthy means of livelihood. 2200 w. Engng—May 7, 1897. No. 12902. 30 cts.

INTERSTATE Commerce.

The Latest Interstate Commerce Decisions. Editorial comment on the decision dealing with the question of the power of the commission to fix rates, and other decisions of the Supreme Court. 1300 w. Bradstreet's—May 29, 1897. No. 13186. 15 cts.

TRANS-MISSOURI.

The Trans-Missouri Decision. George R. Blanchard. Presents the public necessity for legalized railway compacts; argues that they do not and will not unreasonably restrain trade or commerce; and that their intent is an important feature of their creation, in practice if not in law. 3500 w. Forum—June, 1897. No. 13195. 30 cts.

LABOR.

ACCIDENTS.

Protection to Workingmen in Germany. (Die Wirkung der Deutschen Arbeiterversicherung.) Report of a standing committee of the Workingmen's Beneficial Society. Contains a special investigation of the dangers of acetylene and the reasonable precautions for its safe handling. Two articles. 3500 w. Gesundheits Ingenieur—April 30, May 15, 1897. No. 12780. 60 cts.

APPRENTICES.

The Trade School and the Apprentice Question. W. F. Taaffe. Explains the object of the trade school, and comments on the false ideas concerning it, advising that the period passed at a trade school be deducted from the apprenticeship term. 1400 w. San Plumb—May 1, 1897. No. 12636. 15 cts.

CAPITAL and Labor.

Large Aggregations of Capital. George Gunton. An article written for the N. Y. *Independent.* Showing that in every line of production where the aggregation of capital has increased for permanent productive purposes, the effect has been to improve the quality of the services rendered and reduce the price to the public. The effect in wages, permanent employment, &c., is considered. 2800 w. Gunton's Mag—May, 1897. No. 12608. 30 cts.

Another Step in Promoting the Union of Capital and Labor. George Livesey. The writer is opposed to workers' unions. discusses profit-sharing and various other matters. Discussion. Read before the Inst. of Gas Engs., London. 7500 w. Gas Wld—May 8, 1897. No. 12992. 30 cts.

COMPENSATION Bill.

The Workman's Compensation Bill. The essential clauses of this bill, introduced to the House of Commons by Sir Matthew Ridley, with brief comment. 1000 w. Eng, Lond—May 7, 1897. No. 12906. 30 cts.

EUROPEAN Labor Problems.

Economic and Social Problems in Europe. Discusses the subject matter of four books which have recently been published in England and France. Foundations of Success, by S. de Brath; the Struggle of the Nations, by Prof. Maspero; Made in Germany, by E. E. Williams, and Le Danger Allemand, by Maurice Schwab. 2500 w. Cons Reports—May, 1897. No. 13041. 45 cts.

NON-EMPLOYMENT.

Insurance Against Non-Employment. Paul Monroe. A private enterprise for insuring against non-employment began business with the current year in Chicago. The scheme is outlined and facts stated without passing judgment. 4400 w. Am Jour of Soc—May, 1897. No. 12839. 45 cts.

PROFIT Sharing.

Profit Sharing in England. Information obtained from Mr. George Livesey regarding the social experiment which has been successfully tried by the South Metropolitan Gas Company, of London. 4500 w. Cons Repts—May, 1897. No. 13042. 45 cts.

STRIKE.

The New Retort-House Rules at the Leeds Gas-Works. A statement of the trouble on account of dissatisfaction with the new code of rules. The men submit an alternative set. A strike resulted, but the men finally agree to try the new rules. 3800 w. Jour Gas Lgt—April 27, 1897. No. 12665. 30 cts.

The New Retort-House Rules at the Leeds Gas Works. Gives the results of the trial made of the committee's rules. 1100 w. Jour Gas Lgt—May 4, 1897. No. 12852. 30 cts.

Some Suggestions Concerning Strikes. Frank L. McVey. Some remarks on the dangerous and expensive character of strikes, the reason for their existence, the elements which make them difficult to deal with, and general suggestions. 2400 w. Eng's Year Book, Univ of Minnesota, 1897. No. 13000. 45 cts.

Trades Unionism and Strikes. Comments on the change of feeling apparent among trades unionists, very much more adverse to reckless adoption of extreme measures; reference is made to the attitude of the Amalgamated Society in England. 1700 w. Prac Eng—April 23, 1897. No. 12605. 30 cts.

TRUSTS.

The Trust and the Working-Man. Lloyd Bryce. Presents the difficulties in the way of legislating against these industrial agreements, and shows that so far from injuring the public, they have borne their share in benefitting it. 5000 w. N Am Rev—June, 1897. No. 13220. 45 cts.

WAGES.

Senator Elkins and American Wages. Comments on the attitude of Senator Elkins, and some of the leading journals, in declaring that wages must go down. 1300 w. Gunton's Mag—June, 1897. No. 13251. 30 cts.

Work and Wages of Men, Women and Children. The results shown in the Eleventh Annual Report of the Commissioner of Labor, covering

the employment and wages of women and children as compared with men in like occupations, how far women and children are superseding men, and the relative efficiency of men, women and children when employed in doing like work. 8000 w. Bul Dept of Labor—May, 1897. No. 12613. 45 cts.

MISCELLANY.

BOSTON.

The Port of Boston. Some facts concerning New England's metropolis, its harbor, exports and imports, &c. Ill. 1600 w. Sea—May 20, 1897. No. 12980. 15 cts.

EXPOSITION.

The Importance of the Universal Exposition of 1900. J. C. Charpentier. Forecasting the scope of the approaching Paris Exposition and the features that will distinguish it. 3200 w. Eng Mag—Juue, 1897. No. 13256. 30 cts.

The Paris Exposition of 1900. (Die Pariser Weltausstellung im Jahre 1900.) The first of a series of articles by Herr Bömehes, to be continued as the work progresses. This instalment contains comparative accounts of the previous Paris Expositions. 2500 w. Zeitschr d Oester Ing u Arch Ver—April 2, 1897. No. 12716. 30 cts.

Paris Exposition of 1900. (Exposition de 1900). Miscellaneous notes concerning the progress of the work, with full-page bird's-eye view of the grounds and buildings. 2000 w. Le Génie Moderne—May 1, 1897. No. 12741. 30 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

ALLOYS.

Improvements in the Electrolytic Separation of Metallic Alloys. (Neuerungen in der Herstellung von Metall-Legierungen auf Elektrolytischem Wege.) Indicating a number of possible technical operations of electrolytic separation including also combinations of metals and metalloids. 2500 w. Zeitschr für Elektrochemie—March 5, 1897. No. 12451. 15 cts.

CARBON.

The Electrochemical Equivalent of Carbon. (Das Elektrochemische Aequivalent des Kohlenstoffs.) A number of experimental determinations give values closely approximating that due to theory. 1000 w. Zeitschr f Elektrochemie—April 5, 1897. No. 12770. 30 cts.

DECOMPOSITION.

Electrolytic Apparatus for Decomposition of Salt Solutions. (Elektrolytischer Apparat zur Zerselzung von Salzlösungen.) A description by Dr. Koch of his improved apparatus, using a quicksilver cathode. 2000 w. Elektrochemische Zeitschr—May, 1897. No. 12767. 30 cts.

The Chemical Decomposition of Sulphur. (Ueber die Chemische Zerlegbarkeit des Schwefels.) A paper by Theodor Gross, in which he describes an electro-chemical decomposition of sulphur and the isolation of a new element called Bythium. 5000 w. Elektrochemische Zeitschr—April, 1897. No. 12764. 30 cts.

ELECTROLYSIS.

Laboratory Apparatus for Electrolysis. (Laboratoriums-Apparat für Electrolyse.) Describes various forms in which the electrolyte may be at rest or circulating; enabling a variety of electrochemical reactions to be observed. 2000 w. Zeitschr f Elektrochemie—April 20, 1897. No. 12772. 30 cts.

Report upon Work with Electrolysis. (Bericht über die Arbeit mit Elektrolyse.) An account of the commercial results of electrolysis in the Stepanowka sugar refinery and the chemical and mechanical economies obtained. 6000 w. Elektrochemische Zeitschr—April, 1897. No. 12765. 30 cts.

The Extraction of Metals from Their Ores by Means of Electrolysis. Extracts from a report by C. Schnabel in the Chemiker Zeitung. This particular report refers to the non-ferrous metals, and deals with zinc, gold, silver, nickel, copper and aluminum. 1400 w. Elec Rev, Lond—April 23, 1897. No. 12595. 30 cts.

See also Street and Electric Railways.

POTASSIUM Percarbonate.

The Production and Properties of Potassuim Percarbonate. (Ueber die Darstellung und die Eigenschaften des Kalium-Percarbonats.) An account by Prof. Hansen, of the electrolytic production of percarbonate of potassium, in the laboratory of the Zurich Polytechnic. 3000 w. Zeitschr f Elektrochemie—April 20, 1897. No. 12771. 30 cts.

LIGHTING.

ARC LIGHTING.

Arc Lighting in America and Europe. C. Wiler. Abstract of paper read before the Chicago Elec. Assn. Showing the conditions under which arc lighting developed in Europe and America, and the results as a consequence of these varying conditions. 2800 w. Elec Eng—May 5, 1897. No. 12628. 15 cts.

ARTIFICIAL Light.

Artificial Light: Modern Methods Compared—Electric-Incandescent, Welsbach, Acetylene. D. S. Jacobus. A lecture introduced by experiments in colors, discussing candle-power developed per cubic foot of gas, electrical energy to produce the electric light, relative heating and contamination of atmosphere, explosive properties of acetylene, &c. 3600 w. Jour Fr Inst—May, 1897. No. 12646. 45 cts.

BLOOMHILL, Eng.

The Bloomhill Electrical Installation. David Salomons. A brief outline of the history of the plant and a general survey, with illustrations. Describes the installation and laboratories. 4000 w. Am Elect'n—May, 1897. No. 12865. 15 cts.

COATBRIDGE.

Coatbridge: Old and New. Illustrations of the remodelled station, where a gas plant has been abandoned in favor of steam engines, with a study of the causes that led to failure. 3300

w. Elect'n—May 7, 1897. No. 12925. 30 cts.

FILAMENTS.
High-Voltage Lamp Filaments. Alfred H. Gibbings. Deals with double- and single-filament lamps, preferring the latter. Ill. 1000 w. Elec, Lond—April 30, 1897. No. 12696. 30 cts.

GAS Engines.
Electric Lighting by Gas Engines. F. W. Richart. Discusses the problem of choosing an engine, the methods of governing, efficiency, faults, and general operation. 2800 w. Technograph. No. XI. No. 13034. 45 cts.

HARROW.
Harrow Electricity Works. Illustrated detailed description. 3300 w. Elec Eng, Lond—May 14, 1897. No. 13099. 30 cts.

HOSPITAL Lighting.
The Construction, Installation, and Performance of the Electric-Lighting Plant at the Government Hospital for the Insane at Washington, D. C. G. W. Baird. Description and data of performance. 4400 w. Jour of Am Soc of Nav Engs—May, 1897. No. 12910. $1.25.

ILLUMINATION.
Experimental Researches in the Efficiency of Lighting. (Versuche mit Verchiedenen Beleuchtungsarten.) Tabulated results of comparative tests for lighting of schools. The results are for arc and incandescent electric lamps, and for ordinary, Siemens, and Welsbach gas lamps. 1500 w. Zeitsch d Oesterr Ing u Arch Ver—May 7, 1897. No. 12727. 30 cts.
The Production and Utilization of Light Waves. (Ueber Entstehung und Ausnützung von Lichtwellen.) An investigation of the illuminating efficiency and cost of various modes of artificial lighting, including the heating and color effects. 1500 w. Gesundheits Ingenieur. April 30, 1897. No. 12779. 30 cts.
See also "Lighting," below.

INCANDESCENT Lamp.
Glowing of Disconnected Incandescent Lamps. N. S. Amstutz. Unpublished data with reference to experiment previously published. Ill. 1100 w. Elec—May 12, 1897. No. 12861. 15 cts.
Incandescent-Lamp Efficiency: Its Importance to Central Stations. H. L Monroe. Read before Texas Gas and Electric Light Assn. Considers the light producing efficiency, lamp renewals, economy, &c. Discussion follows. 6300 w. Am Gas Lgt Jour—May 17, 1897. No. 12926. 15 cts.

INTERIOR Wiring.
Tubing for Interior Electric-Lighting Wires. Charles Henry Davis and Howard C. Forbes. The subject is considered from the commercial and from the engineering standpoint. Ill. 2000 w. Elec Rev—May 19, 1897. No. 12938. 15 cts.
Uninsulated Pipe for Interior Wiring. V. Zingler. The object of the paper is to compare the uninsulated pipe with the insulated, from a practical point of view, and in the latter part of the article hints for its efficient installation will be given, taken from the result of actual experience. 2500 w. Elec Rev, Lond—May 7, 1897. Serial. 1st part. No. 12920. 30 cts.

LIGHTING.
Electric Lighting. H. H. Norris. Illustrated description of the incandescent lamp and the arc lamp. 3300 w. Sib Jour of Engng—May, 1897. No. 12963. 30 cts.
See also "Illumination," above.

OPTICAL Lantern.
The Electric Light in the Optical Lantern. Cecil M. Hepworth. A consideration of points necessary to get the greatest amount of light and send it in the right direction. 2000 w. Sci Am Sup—May 15, 1897. No. 12858. 15 cts.

PARIS.
Lighting Station of the Champs-Elysées at Levallois. (Usine de la Compagnie d'Éclairage Électrique du Lecteur des Champs-Élysées a Levallois.) Illustrated description of one of the largest stations in Paris. The alternating generators are built up on the fly wheels of the large Corliss engines. 3000 w. 1 plate. La Revue Technique—April 25, 1897. No. 12734. 45 cts.

STATION Enlargement.
Enlargement of One of the Central Stations of the Municipal Electric-Light Company, Brooklyn, New York. Illustrated description and data of the Rodney street station, which contains some of the latest improvements in electrical engineering. 1800 w. Elec Wld—May 29, 1897. No. 13212. 15 cts.

STATIONS.
Small Electric Stations by the Esslingen Machine Works. (Einige Kleinere Elektrizitätswerke der Maschinen Fabrik Esslingen.) Describing and illustrating several well-arranged lighting and power plants of moderate size. 5000 w. Zeitschr d Ver Deutscher Ing—May 15, 1897. No. 12713. 30 cts.

STREET Lighting.
See Municipal Engineering, Streets and Pavements.

THEATRE.
The New Empire Palace, Glasgow. Brief description devoted mostly to the electrical installation. Ill. 1000 w. Elec Eng, Lond—April 23, 1897. No. 12600. 30 cts.

VACUUM Tubes.
Some Researches with Vacuum Tubes. (Einige Versuche mit Vakuumröhren.) Investigating the fluorescent action, and discussing the researches of Korda, Oudin and Colardeau. 2000 w. Elektrotechnische Zeitschr—May 6, 1897. No. 12763. 30 cts.
Vacuum-Tube Lighting. An account of a private seance given by D. McFarlan Moore at his laboratory, to a number of invited guests, to demonstrate the progress made in vacuum-tube lighting. Also editorial. 1200 w. Elec—June 2, 1897. No. 13242. 15 cts.

POWER.

ACCUMULATORS.
See same title under Street and Electric Railways.

ALTERNATOR.
A Novel Three-Phase Alternator. Geo. D. Shepardson. Illustrated description. 1100 w. Eng's Year Book, Univ of Minn—1897. No. 13003. 45 cts.

ARMATURES.

Armature Reaction and the Theory of Commutation. C. C. Hawkins. Part first considers the reaction of a single inductor, the steady E. M. F. of a single inductor unaffected, and self-excitation with separate magnet winding. 1700 w. Elect'n—April 30, 1897. Serial. 1st part. No. 12813. 30 cts.

Heating of Armatures. George Moffat. Treats of the cause of undue heating and the requisites for cool running. 1200 w. Elec Eng—May 26, 1897. No. 13118. 15 cts.

CHARGES.

The Tariff for Supply of Current from Electric Stations. (Die Stromtarife bei Elektricitätswerken.) A paper before the German Electrotechnic Society discussing the rate of charges for current for light and power in the various cities of Germany, with curves showing the relations. 7500 w. Elektrotechnische Zeitschr—April 22, 1897. No. 12761. 30 cts.

CURVES.

Curve Construction. (Ueber Kurvenaufnahmen.) Describing Joubert's method of plotting the curves of alternating currents. 2000 w. Elektrotechnische Zeitschr—April 15, 1897. No. 12757. 30 cts.

DYNAMO.

A Multifunctional Dynamo. George D. Shepardson. Describes the Edison dynamo of the Univ. of Minn. as an example of the value and flexibility of electrical machinery. 1500 w. Eng's Year Book, Univ of Minn—1897. No. 13008. 45 cts.

Dynamo Characteristics. Wilbur M. Stine. Considers the effect of armature reaction, and the causes for the departure of actual curves from their theoretical outlines. 1100 w. Am Elect'n—May, 1897. No. 12866. 15 cts.

ELECTRIC Plant.

See same title under Street and Electric Railways.

ELEVATORS.

The Performance of the Sprague Electric Elevators in the Minneapolis City Hall and County Court House. Frank J. Sprague. Full report of the committee employed by the commissioners to test the machines. 1500 w. Elec Eng—May 12, 1897. No. 12854. 15 cts.

Practical Construction of Rheostats for Electric Elevators. F. M. Everett. Considers the requirements and the existing conditions under which the rheostat is to operate, with drawings illustrating types used upon modern electric-elevator engines. 1400 w. Technograph—No. XI. No. 13029. 45 cts.

FACTORIES.

Transmission of Power in Factories by Electricity. S. V. Clirehugh. Read before the Northern Society of Electrical Engs. Points in connection with power distribution, especially in factories devoted to the textile trades. 4000 w. Ind & Ir—May 21, 1897. No. 13216. 30 cts.

Electrical Power-Equipment for General Factory Purposes. Dugald C. Jackson. A summary of the more recent results, and a résumé of the views held in a number of the great manufacturing establishments where experience has been had with electrical transmission and distribution of power. 4500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13049. 45 cts.

GENERATORS.

Theory of the Three Wire Generator with Double Field System. (Theorie der Dreileitermaschinen nach dem Doppelfeldsystem.) An historical review of the subject by Herr Rothert, with an account of his own improved construction. Two articles, 6000 w. Electrotechnische Zeitschr—April 23 and 29, 1897. No. 12759. 60 cts.

MACHINE Shop.

See title "Electricity" under Mechanical Engineering, Shop and Foundry.

MANUFACTURING Plants.

The Equipment of Manufacturing Establishments with Electric Motors and Electric-Power Distribution. Leland L. Summers. Conclusions from results obtained in fourteen different establishments, as given in Prof. Jackson's paper before the W Soc of Engs. 800 w. Elec Engng—May 15, 1897. No. 12874. 15 cts.

MARINE Engineering.

Electrical Transmission of Power. F. Von Kodolitsch. Read before the Inst. of Naval Arch'ts. Application of electrical transmission of power in marine engineering and ship building. 3500 w. Engng—April 30, 1897. No. 12687. 30 cts.

MOTOR.

Rotary Current Motors with Variable Number of Poles. (Drehstrommotoren mit Variabler Polzahl.) The phases can be divided into groups by a peculiar system of connections, practically corresponding to a change of winding. 1500 w. Electrotechnische Zeitschr—May 6, 1897. No. 12762. 30 cts.

See also "Electric Motor" under Mechanical Engineering, Engines and Motors.

POWER Plant.

The Power Plant, Pipe Line and Dam of the Pioneer Electric-Power Company of Ogden, Utah. Henry Goldmark. Describes in detail these works recently built in the cañon of the Ogden River, which constitute the most important hydraulic-power plant of Utah, and one of the largest works of the kind in the country. 20500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13127. 75 cts.

PUMPING.

Electric Pumping. A. T. Maltby. Electric power as available for pumping is considered under three heads, based on the nature of the generating power, with illustrations of various plants. An account of the present stage of advancement of this branch of electrical application. 1700 w. Am Elect'n—May, 1897. No. 12868. 15 cts.

RATING.

On Rating Electric-Power Plants upon the Heat-Unit Standard. William S. Aldrich. States the advantages of having such a standard for this purpose founded upon the heat unit basis, and discusses the various phases of the subject. 4200 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13061. 45 cts.

SAFETY Device.

See Street and Electric Railways.

ST. ANTHONY Falls.

The St. Anthony Falls Electric-Transmission

Plant. Illustrated description of the plant that operates all the street railways of Minneapolis and St. Paul. 2000 w. St Ry Jour—June, 1897. No. 13193. 45 cts.

TRANSFORMER.

The Alternate-Current Transformer. The first of a series of articles on the construction and design of alternate-current transformers, and the part played by them in the distribution of electricity. 1500 w. Elec, Lond—May 21, 1897. Serial. 1st part. No. 13200. 30 cts.

Direct-Current Transformer. C. Thordarson. Read before the Chicago Elec. Assn. Presents the advantages of the direct continuous current as a method for transmitting electrical energy, and discusses the objections to the direct-current transformer. 1500 w. W Elect'n—May 29, 1897. No. 13144. 15 cts.

TRANSMISSION.

Long-Distance Transmission at Bakersfield, Cal. Illustrated description of plant for utilizing the power of Kern river. 800 w. St Ry Rev—May 15, 1897. No. 12952. 30 cts.

Power Transmission by Three-Phase and Continuous Currents. G. L. Addenbrooke. A presentation of the changed conditions and the points to be considered in any argument of a continuous versus a three-phase power transmission. 2000 w. Elec Rev, Lond—April 30, 1897. No. 12819. 30 cts.

The Bellegarde Electric-Power Transmission. C. S. Du Riche Preller. Illustrated description of the utilization of the water power of the Rhone at Bellegarde, 20 miles below Geneva. 2000 w. Engng—May 14, 1897. Serial. 1st part. No. 13075. 30 cts.

The St. Lawrence Power-Transmission Scheme. Brief description of the project to utilize the waters of the St. Lawrence in the neighborhood of the township of Massena. 1800 w. Elec Eng, Lond—May 21, 1897. No. 13215. 30 cts.

TURNTABLE.

See Railroad Affairs, Terminals and Yards.

TELEGRAPHY AND TELEPHONY.

BERLINER Patent.

Decision in Favor of American Bell Telephone Company Sustaining Legality of the Issuance of the Berliner Patent. Brief statement of the case with conclusions. 2000 w. Elec Eng—May 12, 1897. No. 12855. 15 cts.

Has the Berliner Patent Expired? In the opinion of Geo. H. Benjamin, an eminent patent attorney, it expired in 1894, through the expiration of a prior English patent to Berliner. 500 w. Elec Rev—May 26, 1897. No. 13109. 15 cts.

The Effect of the Berliner Decision. A summary of opinions from various telephone companies and telephone men. 3000 w. Elec Wld—May 15, 1897. No. 12943. 15 cts.

The Full Text of the Opinion in the Berliner Case. 13800 w. Elec Wld—May 22, 1897. No. 13095. 15 cts.

The History of the Berliner Patent. The complete history of the patent is briefly given. Ill. 1200 w. Elec Wld—May 15, 1897. No. 12942. 15 cts.

CABLE LAYING.

Rapid Cable-Laying for War Purposes. Lieut. Crutchley and C. Scott Snell. Describes an apparatus which it is claimed can safely lay a submarine cable at any rate of speed within the compass of the fastest cruiser, and sketches a plan showing how this might be of value in war-time. Ill. 2400 w. Elec Rev, Lond—May 14, 1897. Serial. 1st part. No. 13087. 30 cts.

CABLES.

Disturbance of Submarine Cable Working by Electric Tramways. A. P. Trotter. Paper read before the Inst. of Elec Engs. An account of troubles at Cape Town, caused by the electric tramway service, and the experiments made to remedy the trouble. 4000 w. Elect'n—May 14, 1897. No. 13093. 30 cts.

Ocean Depths. Difficulties to be met in laying the Pacific cable are reviewed, and statements appearing in other papers criticized. 1700 w. Elec Rev, Lond—April 30, 1897. No. 12820. 30 cts.

Sullivan's Method of Determining the Relative Positions and the Top and Bottom Ends of Several Cables in a Tank. Alex. Taylor describes the method of H. W. Sullivan, treating the two tests separately. The relative positions are determined by the strength of the current induced in each one, and the order of their ends by the direction of this current. 2000 w. Elect'n—May 14, 1897. No. 13092. 30 cts.

The Drying of Air-space Cables (Das Austrocknen von Luftraumkabeln.) Describes apparatus for removing the moisture from air insulated cables by chemical means, as used in Paris. 3000 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12754. 30 cts.

ELECTRICAL Testing.

Electrical Testing for Telegraph Engineers. J. Elton Young. Extracted from a forthcoming work to be published by the Electrician Co. The theory and practice of testing as applied to all electrical lines is reviewed. 2000 w. Elect'n—April 30, 1897. Serial. 1st part. No. 12812. 30 cts.

REPEATER.

The Telephone Repeater. F. Jarvis Patten. Describes and illustrates a few of the types, showing how difficult it is to determine from a sketch what will work and what will not. The writer has never found a repeater that worked satisfactorily. Ill. 1800 w. Elec Wld—May 22, 1897. No. 13094. 15 cts.

SYNCHRONOGRAPH.

The Synchronograph—A New Method of Rapidly Transmitting Intelligence by the Alternating Current. Albert C. Crehore and George O. Squier. Experiments upon a new electrical system of rapid intelligence-transmission and its possibilities. Ill. 12500 w. Trans Am Inst of Elec Engs—April, 1897. No. 13046. 45 cts.

TELEGRAPH.

Telegraphing without Wires. (La Télégraphie sans Fil.) A review of the experiments of Preece, Steinheil and others. 2500 w. La Revue Technique—April 10, 1897. No. 12731. 45 cts.

The Railway Telegraph. G. C. Kinsman. History of the inception of the telegraph, and of its application to train movements. Reminiscences of De Wilmot Smith. 3000 w. Ry Mag—April, 1897. No. 12836. 30 cts.

The Support of Telegraph Wires of Iron and Bronze. (Durchhang von Telegraphendrähten aus Eisen und Bronce.) A discussion of the strains upon telegraph wires for various temperatures and distances between poles. 2500 w. Elektrotechnische Zeitschr—March 11, 1897. No. 12460. 30 cts.

TELEPHONE Plant.

The Cost of Constructing, Operating and Maintaining a Telephone Plant for 2,600 Subscribers. Investigations of a committee showing investment and cost of operation and maintenance, with detailed statement of cost of repairs, &c. 1400 w. Elec Engng—May 15, 1897. No. 12875. 15 cts.

TELEPHONES.

Microphonic Telephonic Action. R. A. Fessenden. An article expressing disagreement with Dr. Berliner's theory. 2400 w. Am Elect'n—May, 1897. No. 12869. 15 cts.

MISCELLANY.

BALANCE.

Investigations with the du Bois Magnetic Balance. (Untersuchungen über die du Bois'sche Magnetische Waage.) By means of the du Bois balance the magnetic properties of various irons or steels may be precisely investigated, and graphical curves constructed from the results. 3500 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12755. 30 cts.

CARBON.

The Electrical Action of Carbon in Flames. Richard P. Fuge. Experiments are described, showing the effect of using carbon in one or other of its various forms instead of a metal in the flame. 1800 w. Elec Rev, Lond—May 7, 1897. No. 12921. 30 cts.

CATHODE Rays.

Cathode Rays. J. J. Thomson. Discourse delivered at the Royal Inst. An account of some of the more recent investigations. Ill. 5500 w. Elec'n—May 21, 1897. No. 13213. 30 cts.

See also "Roentgen" and "X Rays."

CONDUCTORS.

Behavior of Discontinuous Conductors Subjected to Electrical Actions. G. Vicentini. A report of investigations, giving experiments on large masses of emulsion, experiments with small masses, and experiments under simple conditions. 1500 w. Elect'n—April 23, 1897. No. 12603. 30 cts.

CURRENTS.

A Rapid Break for Large Currents. A. G. Webster. A description of the apparatus and a test are given. Ill. 1200 w. Am Jour of Sci—May, 1897. No. 12610. 45 cts.

The Effect of Great Current-Strength on the Conductivity of Electrolytes. Theodore William Richards and John Trowbridge. Investigations to determine if the intense current involved in the discharge of a large condenser is capable of causing any change in the condition of an electrolyte. Concludes that it is not essentially affected. 700 w. Am Jour of Sci—May, 1897. No. 12612. 45 cts.

DIRECT Conversion.

The Direct Conversion of Heat into Electricity. Harry Barringer Cox. Abstract of a lecture delivered before the N. Y. Elec. Soc. Describes his work in this field. Discussion follows. 3000 w. Elec Eng—June 2, 1897. No. 13243. 15 cts.

ELECTRICAL History.

Epoch-Making Events in Electricity. G. H. Stockbridge. Arago's experiments and the beginnings of magneto-electricity. 3300 w. Eng Mag—June, 1897. Serial. 3d part. No. 13263. 30 cts.

ELECTRIC Energy.

On the Conversion of Electric Energy in Dielectrics. Richard Threlfall. An account of the writer's experiments, preceded by a brief review of the work of others in the same field. 8000 w. Phys Rev—May-June, 1897. Serial. 1st part. No. 12932. 45 cts.

ETHER.

The Electrical Conductivity of the Ether. John Trowbridge. Outlines a method which enables one to form an estimate of the energy incident upon the production of the Röntgen rays. The experiments made lead to the conclusion that under very high electrical stress the ether becomes a good conductor. 1700 w. Am Jour of Sci—May, 1897. No. 12611. 45 cts.

GALVANOMETER.

Principles and Efficiency of the Mirror Galvanometer. (Konstruktionsgrundsätze und Leistungsfähigkeit Unserer Spiegelgalvanometer.) An elaborate investigation of improved galvanometers especially for the measurement of very weak currents. Serial. 1st part. 2500 w. Zeitschr f Elektrochemie—April 5, 1897. No. 12768. 30 cts.

GERMINATION.

Electro-Germination. Asa S. Kinney. Illustrated description of apparatus and methods. 1300 w. Sci Am Sup—May 15, 1897. Serial. 1st part. No. 12859. 15 cts.

INSTRUMENTS.

Faults in Measuring Instruments. Considers the faults of the voltmeter, the ammeter, the recording wattmeter, and recording ammeter. 2500 w. Am Elect'n—May, 1897. No. 12870. 15 cts.

IRON Cores.

Magnetic Distribution in Short Iron Cores. W. G. Campbell. Results of experiments made for the solution of the questions, What percentage of the total lines of induction produced at the middle of the primary core, passes through the windings of the secondary coil; and what magnetizing force is necessary to produce the required induction in the core. 1800 w. Technograph—No. XI. No. 13036. 45 cts.

LIGHTNING Rods.

The Arrangement of Lightning Conductors. (Ueber die Anlage von Blitzableitern.) Giving precautions as to connections and grounding, together with proportions of surface protected by given arrangements. 2000 w. Elecktrotechnische Zeitschr—April 22, 1897. No. 12760. 30 cts.

MAGNETISM.

A New Action of Magnetism upon Light. (Ueber eine Neue Wirkung des Magnetismus auf

das Licht.) An account of Dr. Zeeman's experiments showing the action of magnetism upon both the emission and absorption spectra. 1500 w. Elektrotechnische Zeitscher—April 15, 1897. No. 12758. 30 cts.

The Influence of Heat Treatment upon the Magnetic Properties of Steel and Iron. Dr. K. E. Guthe. Full paper with discussion and correspondence. A contribution to knowledge of the dependence of magnetic properties on the percentage of carbon present and the character of the heating. 8000 w. Trans Am Inst of Elec Engs—March, 1897. No. 13047. 45 cts.

Useful Conceptions about Magnetic Phenomena. (Hülfsvorstellungen bei Magnetischen Erscheinungen.) A discussion of the phenomena of hysterisis, remanence, permeability, &c., from the metallurgists standpoint, and their relation to various kinds of material. 6000 w. Stahl und Eisen—April 15, 1897. No. 12781. 45 cts.

POLES.

The most Advantageous Spacing of Poles for Supporting Wires. (Ueber die Bestimmung der Günstigen Mastenintervalle bei Fernleitungen.) Discusses the question of the best economy of poles with the proper stresses upon the wires to be supported. 1500 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12753. 30 cts.

REFUSE Destructor.

See Municipal Engineering, Miscellany.

RESISTANCES.

Starting Resistances. E. A. N. Pochin. Considers the different actions of liquid starting resistance and wire resistance. Ill. 2000 w. Elect'n—May 7, 1897. No. 12924. 30 cts.

The Internal Resistance of Galvanic Cells. (Ueber den Innern Widerstand Galvanischer Zellen.) Especially relating to the resistance of various forms of accumulator cells. 2500 w. Zeitschr f Elektrochemie—April 5, 1897. No. 12769. 30 cts..

Virtual Resistance. Irving A. Taylor. Considerations which lead to the conclusion that, in general, the virtual increase of resistance occurring in a conductor traversed by alternating currents is so slight that, when the other more important phenomena occurring in conjunction with it are considered, it may be safely left out of practical calculations. 4500 w. Elec Engng—May 15, 1897. No. 12873. 15 cts.

RIGIDITY.

The Magnetic Increment of Rigidity in Strong Fields. Howard D. Day. Treats of the increase of resistance to torque, produced by magnetization of twisted wires of various diameters, when the magnetic field increases to many times the amount needed to bring out the ordinary magnetic saturation. 2500 w. Am Jour of Sci—June, 1897. No. 13217. 45 cts.

ROENTGEN Rays.

On the Electrification of Gases Exposed to Röntgen Rays, and the Absorption of Röntgen Radiation by Gases and Vapors. E. Rutherford. Experiments which have been made to investigate the way in which electrified gases can be obtained by means of the Röntgen rays, and also to examine the properties of the charged gas. 4500 w. Elect'n—April 23, 1897. No. 12604. 30 cts.

ROENTGEN Tubes.

Tesla on the Hurtful Actions of Lenard and Röntgen Tubes. Gives the writer's experience with the Röntgen rays, relating chiefly to their deleterious action on human tissues. 4000 w. Elec Rev—May 5, 1897. No. 12632. 15 cts.

X-RAYS.

Adjustable X-Ray Focus Tubes. A. A. C. Swinton. Describes and illustrates two forms of adjustable focus tubes. 1200 w. Elec Wld—May 8, 1897. No. 12807. 15 cts.

The Effect of the Density of the Surrounding Gas on the Discharge of Electrified Metals by X-Rays. C. D. Child. Experimental work with brief account of results. 2000 w. Science—May 21, 1897. No. 13024. 15 cts.

The Harmful Effects of the X-Ray. F. S. Kolle. Discusses ideas advanced by Tesla, and gives the writer's experience and opinions. 1200 w. Elec Eng—May 19, 1897. No. 12936. 15 cts.

See also "Cathode" and "Röntgen."

URANIUM.

Continuation of Experiments on Electric Properties of Uranium. Lord Kelvin, J. Carruthers Beattie, and M. S. de Smolan. Read before the Royal Soc of Edinburgh. Results bearing on the conductance induced in air by uranium. 1000 w. Nature—May 6, 1897. No. 12923. 30 cts.

VIBRATIONS.

The Absorption and Emission of Electric Vibrations. (Ueber die Absorption und Emission der Elektrischen Schwingungen.) A theoretical discussion of the relations of electric to other physical vibrations. 2000 w. Die Elektrizität—April 24, 1897. No. 12774. 30 cts.

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ACCIDENT.

The Accident to H. M. S. "Star." Editorial on the accident to the torpedo-boat destroyer, caused by a split cylinder. 1400 w. Engng—May 7, 1897. No. 12901. 30 cts.

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New Scotch Boilers for U. S. S. Chicago. Illustration and brief description of one of the four Scotch boilers. It is the first nickel-steel boiler built in the United States. 1200 w. Marine Engng—May, 1897. No. 12698. 30 cts.

CONTRACT Trials.

The Contract Trials of the U. S. Gunboats Helena and Wilmington. W. S. Smith. Detailed descriptions with account of trials, giving data. Ill. 4000 w. Jour Am Soc of Nav Engs—May, 1897. No. 12914. $1.25.

Contract Trial of the Gresham. C. A. Mc-

Allister. Describes this single-screw steel revenue cutter, built by the Globe Iron-Works Co. of Cleveland, O., giving dimensions, ratios, &c., of the engine, and account of trial trip with data. Ill. 3500 w. Jour Am Soc of Nav Engs—May, 1897. No. 12911. $1.25.

The Official Trial Trip of the U. S. Gunboat "Annapolis." This is the first U. S. government vessel of large size to be fitted with boilers of the water-tube type exclusively. Description and dimensions, with brief report of trial. 500 w. Eng News—May 13, 1897. No. 12878. 15 cts.

DOCKS.

The Position and Prospects of the Milford Docks. A brief history of the undertaking, with the story of the difficulties. Interesting to those concerned in port administration. 3300 w. Trans—May 14, 1897. No. 13097. 30 cts.

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A Leak in the New Dry-Dock, Brooklyn Navy Yard. A statement of the case based on such facts as could be ascertained, with the measures being taken to remedy the defect. 1000 w. Sci Am—May 22, 1897. No. 12966. 15 cts.

ENGINES.

Inglis's Triple-Expansion Paddle-Wheel Engines. Illustrated description of the engines for the paddle-steamer Paris, built for the River Plate Co. 1500 w. Engng—April 30, 1897. No. 12683. 30 cts.

Marine-Engine Designs. William Burlingham. Aims to call attention to facts that ought to be observed in the design of marine engines, especially such as engineering works rarely discuss. 3000 w. Mach, N. Y.—June, 1897. Serial. 1st part. No. 13225. 15 cts.

HIGH Pressures.

High Pressures for Marine Engines. W. R. Cummins. Read before the North-East Coast Inst. of Engs & Shipbuilders. The writer recapitulates the arguments of a former paper as to the economy to be expected from increase of pressure, and touches upon the commercial aspect of the question; considers the type of boiler that will best suit the new conditions, and makes some suggestions as to the design of an engine most suitable for this increased pressure. 2500 w. Prac Eng—April 30, 1897. Serial. 1st part. No. 12815. 30 cts.

MOTOR.

The New Marine Motor. Describes a trip in the Turbinia, which made thirty-eight miles an hour at sea. Ill. 2200 w. Prac Eng—April 30, 1897. No. 12817. 30 cts.

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The Application of the Compound Steam Turbine to the Purpose of Marine Propulson. Charles Parsons. Describes the Turbinia, with a summary of advantages claimed. Trials and abstract of discussion. 3800 w. Jour Am Soc of Nav Engs—May, 1897. No. 12915. $1.25.

SCOW.

Steam Dumping Scow for the Street Cleaning Department of New York. Illustrated description of scow, with brief comment on the efficient work of this department. 1300 w. Sci Am—June 5, 1897. No. 13250. 15 cts.

SHIPBUILDING.

A Useful Wood for Shipbuilding and Docks. An account of tests made on wood treated by a new method to protect it from all danger of combustion. 1000 w. Trans—May 14, 1897. No. 13098. 30 cts.

Shipbuilding, Ancient and Modern. M. W. Aisbitt. Abstract of paper read at meeting of the Bristol Channel Center of the Inst. of Marine Engs. Considers the proportions of the Ark, other ancient vessels, modern wooden vessels, advent of iron and steel, a steamer's requirements. 2500 w. Steamship—May, 1897. No. 12805. 30 cts.

SHIP-YARDS.

The Military Value of the Ship-Yard. Lewis Nixon. Résumé of the history of the U. S. naval reconstruction and survey of the existing situation, with comparison or constrast with the policy of Great Britain. 6000 w. N Amer Rev.—June, 1897. No. 13218. 45 cts.

STABILITY.

Hints on Elementary Stability, with Remarks on Water Ballast. A. S. Thomson. Read before the Shipmaster's Society, London. A study of the relation of the center of buoyancy to the center of gravity. 1800 w. Marine Engng—May 1897. No. 12697. 30 cts.

STEAMSHIPS.

Notes on the Estimation of the Power of Steamships at Sea and of Feed and Circulating Water at Sea. Nisbet Sinclair. Read before the Inst. of Engs. & Shipbuilders in Scotland. Part first discusses sea power and shows the importance of providing proper instruments and being able to furnish data of performances. Also begins the discussion of feed- and circulating-water. 2500 w. Ind & Ir—April 30, 1897. Serial. 1st part. No. 12693. 30 cts.

The Steamship La Grande Duchesse. Illustrated description of a new steamer recently built by the Newport News Shipbuilding and Dry-Dock Company. 1200 w. Eng, Lond—May 21, 1897. No. 13210. 30 cts.

TORPEDO Boat.

The Torpedo Boat Porter. Brief illustrated description. 600 w. Sci Am—May 22, 1897. No. 12967. 15 cts.

MECHANICAL ENGINEERING.

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BOILER Practice.

European Boiler Practice, R. S. Hale. Discusses types of boilers, economizers, superheaters, grates, mechanical stokers, boiler fittings, pipe coverings, chimneys, boiler operation, testing, labor in boiler room, steam engines &c. Discussion follows. Ill. 8000 w. Jour Assn of Enging Soc—April, 1897. No. 13016. 30 cts.

BOILER Prices.

Current Boiler Prices for Large Electrical Plants. An account of the bids for boilers re-

ceived by the United States Electric Lighting Co., of Washington, D. C. 600 w. Elec Eng—May 26, 1897. No. 13117. 15 cts.

BOILERS.

Boilers and the Use of Steam. William H. Bryan. A lecture delivered before the Wage Earners Self-Culture Club, St. Louis. Discusses what steam is, principal uses, types of boilers and of engines, efficiency of boilers and engines. 4000 w. Age of St—May 8, 1897. No. 12834. 15 cts.

BOILER Test.

Evaporation Test of a Boiler with Eccentric Internal Furnace Flue. (Verdampfungsversuche an einem Kessel mit Seitlichem Wellrohre.) A boiler of the Lancashire type, with corrugated furnace flue eccentrically placed. An evaporation of 9.98 lbs of water, and an efficiency of 75.5 per cent. was obtained. 1500 w. Zeitschr d Ver deutscher Ing—May 15, 1897. No. 12714. 30 cts.

Fuel-Gas Analyses in Boiler Tests. R. S. Hale. Describes a few of the devices and methods of obtaining the analyses of gases, with illustrative tests. Ill. 6500 w. Trans Am Inst of Mech Engs. Vol. XVIII.—May, 1897. No. 13064. 45 cts.

BOILER Construction.

Experiments in Boiler Bracing. Francis J. Cole. Investigations into the holding power, at different temperatures, of various styles of locomotive fire-box crown stays. Ill. 1800 w. Trans Am Soc of Mech Engs. Vol. XVIII.—May, 1897. No. 13059. 45 cts.

Man-Hole Frames. Discusses the necessity of providing man-holes, convenient of access, safe &c., with points of importance to be observed in construction. Ill. 1800 w. Lord's Mag—Feb., 1897. No. 12840. 15 cts.

The Reinforcing Openings in Boilers. From "The Locomotive." The details of their safe design. 1700 w. Bos Jour of Com—May 29, 1897. No. 13223. 15 cts.

BOILER Inspection.

A National Boiler-Inspection Law. E. D. Meier. Presents the need of such a law; all that has been done; other countries; and gives suggestions for early and complete accomplishment of the desired end. 4000 w. Jour Assn of Engng Soc—April, 1897. No. 13021. 30 cts.

BOILER Waters.

Boiler Waters. S. W. Parr. Classifies in a general way the waters producing harmful results, giving method of analysis. 2800 w. Technograph—No. XI. No. 13032. 45 cts.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. An examination of the devices employed in skimming and filtration. Ill. 8600 w. Eng Mag—June, 1897. Serial. 4th part. No. 13265. 30 cts.

The Quality of the Boiler-Water Supply of a Portion of Northern Illinois. James A. Carney. This subject gives much trouble in Illinois, and after careful analyses the writer concludes that water for boiler purposes should be taken as much as possible from streams, lakes or artificial ponds. 2200 w. Trans Am Inst of Min Engs—May, 1897. No. 13167. 45 cts.

EXHAUST Steam.

Some Considerations of the Economical Use of Exhaust Steam. Willard T. Hatch. Read at meeting of Providence Assn. of Mech. Engs. Considers its use in the heating of buildings and the production of additional power by its use in a condensing engine. 2800 w. Ir Age—May 6, 1897. No. 12634. 15 cts.

FURNACE.

The Down-draught Furnace. A. B. Hazzard. Extract from paper read before the St. Louis Assn. No, 2. of Missouri N. A. S. E. Describes the three ways of setting a furnace, the common grate setting, the understoker, and the down draught, with the principal features of the latter. 1200 w. San Plumb—May 1, 1897. No. 12637. 15 cts.

The "Weardale" Furnace. Henry William Hollis. Abstract of paper read at the Iron and Steel Inst. Illustrated description of the furnace and mode of working. 2500 w. Eng, Lond—May 14, 1897. No. 13074. 30 cts.

RIVETING.

Hydraulic Riveting Plant—Chicago and North-Western Railway. Description with illustrations of the general arrangement of the machinery. 700 w. Am Eng & R R Jour—June, 1897. No. 13237. 30 cts.

SMOKE Prevention.

Report on Smokeless Boiler Plants in Saxony. (Bericht über Rauchfreie Dampfkesselanlagen in Sachsen.) A very full review of Prof. Lewicki's report to the Minister of the Interior, showing the performance of a great variety of furnaces and fuels. Two articles. 12000 w. Zeitsch d Ver Deutscher Ing—April 17 and 24, 1897. No. 12707. 60 cts.

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AIR COMPRESSOR.

The Köster Compound Air Compressor. (Verbund Kompressor, Bauart Köster.) A tandem-compound steam engine and a tandem-compound air-compressor coupled side by side to the same shaft, with cranks at right angles. The air cylinders have mechanically-actuated valves. Efficiency 81 per cent. 3500 w. Zeitsch d Ver Deutscher Ing—April 10, 1897. No. 12703. 30 cts.

CONVERTER.

See Mining and Metallurgy, Iron and Steel.

EFFICIENCIES.

Relative Efficiencies of a Compressed Air Plant Due to Difference of Level Above and Below Sea Level. F. C. Weber. Formula and chart by use of which one may select an air compressor of sufficient capacity to supply a motor with equivalent volume of air, no matter where it may be located. 700 w. Com Air—May, 1897. No. 12964. 15 cts.

LOCOMOTIVE.

See same title under Street and Electric Railway.

MINING Purposes.

The Use of Compressed Air for Mining Purposes. Edward A. Rix. A lecture to the engineering students of Leland Stanford Jr. University. Considers compressed air the only power which is alone sufficient to supply all the power needs of an average mine. 2500 w. Min & Sci Pr—May 15, 1897. Serial. 1st part. No. 12979. 15 cts.

POWER Transmission.

Transmission of Power by Compressed Air. Richard Hirsch. From a paper read before the Eng's Soc. of W. Penn. Describes a proposed plant capable of transmitting 1100 indicated horse power, developed in the motors where used, with the cost of building and operating the same. 1700 w. Am Mfr & Ir Wld—May 14, 1897. No. 12889. 15 cts.

ENGINES AND MOTORS.

BALANCING.

The Influence and Balancing of Moving Masses in Steam Engines. (Die Massenwirkungen der Dampfmaschinen und ihre Balancirung.) A geometrical investigation, including simple and multiple-expansion engines with various crank relations. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—April 30, 1897. No. 12725. 30 cts.

COUPLING.

Theory of Coupling and Connecting Rods. Ivanhoff Veder. Considers the case in relation to slow-running and also high speed engines. 600 w. Prac Eng—May 21, 1897. Serial. 1st part. No. 13214. 30 cts.

CYLINDER Dimensions.

Method for Determining Cylinder Dimensions for Multi-Cylinder Steam-Engines. A. W. Smith. The method is a modification of Prof. Unwin's method, extended to triple expansion, and may be applied to four or more cylinders. 2500 w. Engng Jour—May, 1897. No. 13121. 30 cts.

EFFICIENCY.

The Efficiency of Steam Engines. Considers briefly several standards of efficiency. 1000 w. Am Eng & RR Jour—June, 1897. No. 13234. 30 cts.

ELECTRIC Motor.

The Use of Electric Motors in Machine Shops. Charles H. Benjamin. Discusses the application of electricity to machine tools from the standpoint of the manufacturer and of the mechanical engineer, with a view of determining under what circumstances it is profitable to use that system of power-transmission. 4400 w. Jour Assn of Engng Soc—April, 1897. No. 13014. 30 cts.

ENGINE Proportions.

Current Practice in Engine Proportions. John H. Barr. Results of investigations made upon "low-speed"-engine proportions, with several interesting diagrams. 4000 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13062. 45 cts.

ENGINE Tests.

Tests of Three Sulzer Engines. Hamilton A. Hill. Reports of three tests of large mill engines, built by Messrs. Sulzer Bros., Winterthur (Switzerland), which show unusually fine results. Ill. 2400 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13067. 45 cts.

EXPLOSION Engine.

The Modern Explosion Engine. E. S. Savage. Discusses the requisites of the explosion engine and its advantages, admitting the imperfections, but predicting a bright future. 2500 w. Eng's Year Book, Univ of Minn. 1897. No. 13009. 45 cts.

FANS.

See Mechanical Engineering, Miscellany.

GAS Engine.

A Practical Illustration of the Working of a Large Gas Engine. Ernest F. Lloyd. Gives curve of average working taken from engine at Lancaster, Ohio, with comments. 900 w. Am Gas Lgt Jour—May 17, 1897. No. 12927. 15 cts.

Gas-Engine Requirements. Sidney A. Reeve. An indictment of the shortcomings of gas-engine builders. 2400 w. Elec—May 12, 1897. No. 12862. 15 cts.

See same title under Electrical Engineering, Light.

HIGH-SPEED Engines.

The Rapid Coming in of High-Speed Engines. States their advantages, and the objections when they are built on low-speed models. 3300 w. Engng Mech—April, 1897. No. 12640. 30 cts.

INDICATOR.

A Continuous Steam-Engine Indicator. Thomas Gray. The instrument described was devised with the object of obtaining a record of the performance of a gas engine during a series of successive cycles of operation. Ill. 2000 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13057. 45 cts.

INDICATOR Diagram.

Effect of Piping Arrangements on the Indicator Diagram. D. T. Randall. Experiments with such a selection of data as will best show the differences in results obtained under various conditions of cut-off and pipe lengths. 1500 w. Technograph—No. XI. No. 13031. 45 cts.

LOADING.

The Best Load for the Compound Steam Engine. Albert K. Mansfield. Graphical record of tests of two compounds of Buckeye Engine Co.'s make, both condensing engines, with brief explanation. 500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13066. 45 cts.

OSCILLATING Engine.

Acceleration Diagram for the Oscillating Engine. A. C. Elliott. Acceleration diagrams for the oscillating engine are given and the constructions explained. 1000 w. Engng—May 21, 1897. No. 13151. 30 cts.

PETROLEUM Engines.

Petroleum Engines. Frederick Grover. Part first examines the physical properties of the oil which more directly affect the design of oil engines, and the construction of some early types. Ill. 1300 w. Prac Eng—May 7, 1897. Serial. 1st part. No. 12919. 30 cts.

The Peugeot Petroleum Motor. Describes a recently designed motor, to be used in mechanically propelled carriages. Ill. 2000 w. Engng—May 21, 1897. No. 13152. 30 cts.

WET Steam.

Tests to Show the Influence of Moisture in Steam in the Economy of a Steam Turbine. D. S. Jacobus. Gives conditions of tests and the results. 1300 w. Trans Am Soc of Mech Engs, Vol. XVIII. May, 1897. No. 13054. 45 cts.

STEAM Engines.

The Steam Engines at the Electrical and Technical Exposition at Stuttgart, 1896. (Die Dampfmaschinen auf der Ausstellung für Elektrotechnik und Kunstgewerbe in Stuttgart 1896.) A fully illustrated description of some excellent simple and compound engines adapted for electrical service. 5000 w. Zeitschr d Ver Deutscher Ing—May 8, 1897. No. 12712. 30 cts.

The History and Structure of the Steam Engine. Robert H. Thurston. Early history of the steam engine. First of a series of twelve articles to describe and illustrate the birth and growth of the steam engine to date. Abstracted from "The Manual of the Steam Engine." 6500 w. Ry Mag—April, 1897. Serial. 1st part. No. 12837. 30 cts.

THERMODYNAMICS.

The Heat Diagram of Saturated Vapors, and its Applications to Heat and Cold Engines. (Das Wärme Diagramm der Gesättigten Dämpfe und seine Anwendung auf Heis- und Kalt Dampfmaschinen.) An analytical and geometrical investigation of the entropy diagram by Prof. Ancona, of Milan. Two articles. 10000 w. Zeitsch d Ver Deutscher Ing—April 17, and May 15, 1897. No. 12706. 60 cts.

VALVE Diagram.

The Bicentric Slide-Valve Diagram. (Das Bizentrische Polare Exzenterschieber Diagramm.) A new diagram by chief engineer Brix, of the Russian navy. It determines the valve positions taking into account the angular deviations of the valve and connecting rod. 3000 w. Zeitschr d Ver Deutscher Ing—April 10, 1897. No. 12705. 30 cts.

VALVES.

Valve Lifts. Herbert Aughtie. Diagrams of various valves are given and studied. 1100 w. Prac Eng—May 14, 1897. No. 13115. 30 cts.

WELLINGTON Engine.

The Wellington Engine and Modern Steam-Engine Efficiency Compared. Henry E. Longwell. Exceptions taken to statements made in an article published in this paper, April 21, on the Wellington series engine, with examination of the system. 1200 w. Elec Eng—May 5, 1897. No. 12629. 15 cts.

The Wellington Series Engine. J. E. Johnson, Jr. A criticism of the conception on which Mr. Wellington's ideas are based and concluding that the best steam engines of to-day are as economical as it is commercially practicable to make them. 1200 w. Eng & Min Jour—May 8, 1897. No. 12649. 15 cts.

WIRE Drawing.

Loss by Wire Drawing. W. H. Booth. Shows there is no loss from wire drawing of steam, but that such wire drawing is probably not to be economically employed in place of expansion, save where expansive working is being carried to excess. 1800 w. Mach, N. Y.—June, 1897. No. 13227. 15 cts.

POWER AND TRANSMISSION.

DYNAMOMETER.

A Design for a Dynamometer. L. M. Hoskins. The device is described and illustrated. 800 w. Engng Jour—May, 1897. No. 13122. 30 cts.

A New Form of Transmission Dynamometer. Frederick Bedell. Describes an ingenious device that has been used in the laboratories of Cornell University. 900 w. Trans Am Soc of Mech Engs—Vol XVIII. May, 1897. No. 13065. 45 cts.

POWER Transmission.

The Comparative Economy of Power Transmission by Gas and by Electricity. Questioning statements made in a paper by Nelson W. Perry. 1500 w. Eng News—May 13, 1897. No. 12880. 15 cts.

Electricity versus Shafting in the Machine Shop. Charles H. Benjamin. Showing the economic advantages of the newer system. 4800 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13063. 45 cts.

PROPULSION.

Mechanical Propulsion on Canals. Leslie S. Robinson. Read before the Inst. of Mech Engs. A review of the general question of propulsion or haulage on canals. Also discussion. 7500 w. Engng—April 30, 1897. Serial. 1st part. No. 12686. 30 cts.

STEAM Power.

See Mining and Metallurgy, Iron and Steel.

WATER-WHEELS.

Report of Tests of a 28-inch and 36-inch "Cascade" Water-Wheel Made at the Mechanical Engineering Laboratory of the Ohio State University. Abstract by John H. Cooper. A brief illustrated description of the "Cascade" wheel, with results of a series of tests. 700 w. Jour Fr Inst—May, 1897. No. 12647. 45 cts.

The Principles and Construction of Water-Wheels. W. E. Wines. Read before the Technical Soc. of Armour Inst., Chicago. A few fundamental principles relative to the efficiency of water-wheels in general and to the action of a jet of water upon a vane are laid down, followed by discussion of different classes of water-wheels. 1600 w. Elec Eng—May 12, 1897. Serial. 1st part. No. 12853. 15 cts.

WIND Power.

The Utilization of Wind as a Motive Force. Illustrated description of some modern windmills and a comparison of their advantages with steam power. 1100 w. Mach, Lond—May 15, 1897. Serial. 1st part. No. 13119. 30 cts.

See also "Factories," "Marine Engineering," "Manufacturing Plants," "St. Anthony's Falls," and "Transmission" under Electrical Engineering, Power.

See also "Power Transmission" under Mechanical Engineering, "Compressed Air."

SHOP AND FOUNDRY.

ALUMINUM.

The Working of Sheet Aluminum. From the Aluminum World. Describes lathe work, drawing, spinning, frosting, burnishing. 2500 w. Met Work—May 15, 1897. No. 12876. 15 cts.

BORING.

Universal Boring, Drilling and Milling Machine. Illustrated description of a piece of heavy-tool construction recently supplied by Bement, Miles & Co. to the Bethlehem Iron Co. 1000 w. Am Mach—May 6, 1897. No. 12658. 15 cts.

CASTINGS.

Volumnar Contraction of Castings in Cooling. Francis Schumann. This paper contains addenda to the paper entitled "Contraction and Deformation of Iron Castings in Cooling from the Fluid to the Solid State" and is intended to open and continue discussion on that subject. 500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13052. 45 cts.

CHILLED Iron.

Chilled Iron and Chilling Iron. E. E. Putnam. Read before the convention of the American Foundrymen's Assn. Discusses the crystalline texture, chilled plows, the difficulties in making clean chilled work, &c. 4000 w. Tradesman—May 15, 1897. No. 12933. 15 cts.

CIRCULAR Work.

Fixture for Milling Circular Work. Ed. Snyder. Illustrated description of device designed by the writer. 900 w. Am Mach—May 20, 1897. No. 12965. 15 cts.

CLUTCHES.

Coil Clutches. Describes Lindsay's clutches, manufactured by the Coil Clutch & Pulley Co., of Gotha Works, Slough. Explains the principle and the various forms. 1500 w. Engng—May 7, 1897. No. 12898. 30 cts.

CUPOLAS.

On the General Utility and Economy of Central-Blast Cupolas. Thomas D. West. A discussion of the advantages and sources of economy obtained by the use of the central blast, with outside tuyeres. 3000 w. Ind & Ir—May 14, 1897. No. 13081. 30 cts.

The Cupola and What Goes On in It. A. Humboldt Sexton. Discusses the phenomena attending the melting of pig iron. 2500 w. Prac Eng—May 14, 1897. Serial. 1st part. No. 13114. 30 cts.

CUTTERS.

Inside Pipe Cutters. E. J. Prindle. Illustrated description of various forms of this tool. 1700 w. Loc Engng—May, 1897. No. 12674. 30 cts.

CUTTING.

Cutting Semi-Cylindrical Concavities. B. F. Spalding. Common tools inadequate; grubbing; form of cutter; mode of motion; making joint for vise hinge. Ill. 1800 w. Am Mach—May 6, 1897. No. 12661. 15 cts.

To Cut a Thing in Two and Yet Not Separate It. John H. Cooper. Describes an interesting device which has been several times reinvented. Ill. 700 w. Mach, N. Y—June, 1897. No. 13226. 15 cts.

ELECTRICAL Machinery.

How to Calculate, Design and Construct Electrical Machinery. William Baxter, Jr. The first of a series of articles which proposes to explain in a simple manner the principles upon which electrical machinery acts, and also to give such rules as may be necessary to enable one to calculate the various parts of such machines. 3000 w. Mach, N. Y—June, 1897. Serial. 1st part. No. 13229. 15 cts.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. Setting forth the reasons that determine the choice of electric motive-power. Ill. 3600 w. Eng Mag—June, 1897. Serial. 1st part. No. 13258. 30 cts.

FLY-WHEELS.

A Canadian Example of Heavy Fly-Wheel Construction. Illustrated description of processes used in the construction of heavy fly-wheels. Taken from the Laurie Engine Company's shops, at Montreal. 800 w. Am Mach—June 3, 1897. No. 13245. 15 cts.

FOUNDRY.

Foundry Elevators and Yard Cranes. G. A. True. Read at convention of the American Foundrymen's Assn. Describes devices introduced in modern foundries with great advantage. Ill. 2000 w. Ir Trd Rev—May 20, 1897. No. 13043. 15 cts.

GEAR Teeth.

Helical Gear Teeth. A. M. Mortley. An illustrated description of method of building helical gears. 800 w. Mach, N. Y—June, 1897. No. 13230. 15 cts.

Diagrams for Relative Strength of Gear Teeth. Forrest R. Jones. Diagrams constructed with a view to facilitating the determining of the sizes and pitches of gears which are suitable to withstand a known or assumed pressure transmitted to them by an intermeshing gear. 2200 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13068. 45 cts.

GEAR Wheels.

The Construction of Cast-Iron Gear Wheels. Herbert Aughtie. Suggests a method of moulding gear wheels that does not involve the use of a machine, while at the same time largely avoiding the sources of expense and inaccuracy inherent in the alternative methods in general use. 2000 w. Prac Eng—April 23, 1897. No. 12606. 30 cts.

GRINDING.

Machine Grinding. C. H. Norton. The article is written to help clear away misunderstandings, and open the way to the more profitable use of grinding. Part first gives suggestions for using the grinding machine successfully. 3000 w. Am Mach—May 6, 1897. Serial. 1st part. No. 12659. 15 cts.

MOLDING.

An Unusually Difficult Molding. Describes and illustrates an interesting work connected with the manufacture of heaters made by the Mitchell Heater Co., of Poughkeepsie, N. Y. 700 w. Ir Age—May 13, 1897. No. 12860. 15 cts.

PATTERN Making.

Practical Pattern Making. I. McKim Chase. Part first refers to the materials that have been used in pattern making, and the various methods of molding. 2500 w. Mach, N. Y.—June, 1897. Serial. 1st part. No. 13228. 15 cts.

PLANER.

A New Planer Drive. John Randol. Describes and approves the Whitcomb planer and pronounces the "bull wheel" an unwarranted construction expense, apparently serving no useful purpose. Ill. 1100 w. Am Mach—May 13, 1897. No. 12891. 15 cts.

Something New in Planers. Illustrates and briefly describes a pneumatic reverse planer, the

invention of Alexander Gordon, and brought out by the Niles Tool Works. 600 w. Am Mach—May 13, 1897. No. 12892. 15 cts.

TEMPERING.

Practical Tempering of Steel. W. B. Braucher. Describes peculiarities of steel noticed while working with several kinds of steel in the same set of knives which were being re-sharpened and hardened. 1500 w. Technograph—No. XI. No. 13030. 45 cts.

TOOLS.

The Resistance of Metals to Machining. (Die Grösse der Widerstände gegen das Abheben von Metallspänen.) An investigation into the resistance of metals to planing, boring, turning, &c., based upon experimental data, for use in determining the proportions of machine tools. 5000 w. Zeitschr d Ver Deutscher Ing—May 1, 1897. No. 12710. 30 cts.

Two Valuable Shop Tools.—L. & N. Ry. Illustrated description of a 25-ton hydraulic press, and a drill-press link-slotter used in the Louisville shops of this road. 1400 w. Ry Mas Mach—May, 1897. No. 12695. 15 cts.

In the Shops. Illustrated description of the reconstruction of old machines for the performance of special work. 600 w. Ry Age—May 7, 1897. No. 12828. 15 cts.

MISCELLANY.

ACCELERATIONS.

The Accelerations of the Links of a Mechanism. G. A. Goodenough. The object of the article is to apply stated principles and constructions to one or two simple mechanisms and thus furnish concrete examples for the aid of those who wish to study this subject. Diagrams. 2300 w. Technograph—No. XI. No. 13027. 45 cts.

AERONAUTICS.

Our Teachers in Sailing Flight. Otto Lilienthal. An account of the writer's observation of storks in the village of Vehlin in Ostprignitz. 2700 w. Aeronautical Annual—1897. No. 13204. $1.

Recent Advances Toward a Solution of the Problem of the Century. A. M. Herring. The writer classifies all methods under four heads and examines the advantages and disadvantages of each class, reviewing the work in this field. Ill. 8500 w. Aeronautical Annual—1897. No. 13203. $1.

Recent Experiments in Gliding Flight. O. Chanute. The author reached the conclusion that the maintenance of the equilibrium under all circumstances, was the most important problem to solve. The article gives the experiments made and illustrates and describes the designs used, giving the degree of success attained by the apparatus, and much information. 8000 w. Aeronautical Annual—1897. No. 13202. $1.

Screw-Propellers Working in Air. Hiram S. Maxim. Brief account of experiments. 1000 w. Aeronautical Annual—1897. No. 13206. $1

Story of Experiments in Mechanical Flight Samuel Pierpont Langley. A narrative account of the writer's work in aerodromics, and of the successful flight of his aerodrome. Ill. 6500 w. Aeronautical Annual—1897. No. 13201. $1.

The "Flying Machine." S. P. Langley. An informal and popular account of the author's experiments with flying-machines, built chiefly of steel, driven by steam-engines. Ill. 8000 w. McClure's Mag-June, 1897. No. 13162. 15 cts.

The Way of An Eagle in the Air. E. C. Huffaker. A study of the art of soaring, with account of experiments. 6400 w. Aeronautical Annual—1897. No. 13205. $1.

ANGULAR VELOCITY.

On a Means of Producing a Constant Angular Velocity. A. G. Webster. Describes an arrangement used by the writer, with practical test of the method, showing it to be of undoubted usefulness in absolute determinations. 1500 w. Am Jour of Sci—May, 1897. No. 12609. 45 cts.

BELTING.

Rules for Belting. Presents conclusions arrived at from practical rather than theoretical considerations with a view to drawing out discussion. A nine-years' experiment in belting in the machine shop of the Midvale Steel Co., Phila., is given. 3000 w. Engng Mech—May, 1897. No. 13022. 30 cts.

BICYCLES.

The Women's Bicycle and Its Predecessors. E. D. Sewall. Illustrated historical account of the development of the bicycle, especially as used by women. 6000 w. Ir Age—May 6, 1897. Serial. 1st part. No. 12633. 15 cts.

CHEMISTRY.

Chemistry as an Elective for Engineers. F. F. Sharpless. Showing the importance of chemistry in the practice of the engineering profession. 3400 w. Eng's Year Book, Univ of Minn.—1897. No. 13002. 45 cts.

CONDENSATION.

The Laws of Cylinder Condensation. Arthur L. Rice. Studies the action of condensation, and the factors that control it. Gives formula for estimating condensation, and table of data. 7200 w. Trans Am Soc of Mech Engs-Vol. XVIII.—May, 1897. No. 13060. 45 cts.

DISCUSSIONS.

Topical Discussions and Notes of Experience. Steam distribution at early cut-off, by E. J. Armstrong. Tests of the efficiency of the bicycle, by Jno. G. D. Mack; Note on old windmill gearing, by C. W. Hunt; Basement floors for machine shops, by Jno. E. Sweet: Crystallization by shock, by Gus. C. Henning. 5700 w. Trans Am Soc of Mech Engs-Vol. XVIII—May, 1897. No. 13053. 45 cts.

EXTENSIMETER.

A Mirror Extensimeter. Gus. C. Henning. Illustrated description of a form of this apparatus designed by the writer to simplify and facilitate its use. Ill. 1800 w. Trans Am Soc of Mech Engs-Vol. XVIII—May, 1897. No. 13051. 45 cts.

FANS.

Experiments upon Propeller Ventilating-Fans, and Upon the Electric Motor Driving Them. William George Walker. Read before the Inst. of Mech Engs. Illustrated description of experiments made on propeller ventilating-fans. 2000 w. Elec Eng, Lond—May 14, 1897. No. 13100. 30 cts.

FORMULAE.

Formulæ Explained. Otto Dietrich. The

first of a series of articles explaining matters not understood by all engineers, mostly of a mathematical character. 1000 w. Sta Eng—May, 1897. Serial. 1st part. No. 12657. 15 cts.

INSPECTION.

Inspection—Its Place in Modern Engineering Practice. A. C. Beyer. Some account of the methods employed and work accomplished by inspectors. 2500 w. Eng's Year Book, Univ of Minn—1897. No. 13004. 45 cts.

INVENTION.

Cultivation of the Inventive Faculty by the Solution of Constructive Problems. Leicester Allen. Presentation of two solutions of problem 8, with comments. 1100 w. Am Mach—May 13, 1897. No. 12893. 15 cts.

INVENTOR.

The Story of an Inventor. William Walsh. Reprint from Overland Monthly. History of the patent case of A. B. Bowers. 8000 w. Overland M—Feb., 1897. No. 12671. 45 cts.

JOURNALS.

Experiment with an Air-Lubricated Journal. Albert Kingsbury. Describes an apparatus for exhibiting the action of fluid lubricants in cylindrical bearings, with a statement of results of a large number of tests made at various speeds, measuring the pressures in the lubricant, thickness of the film of lubricant, and the friction. Ill. 6000 w. Jour Am Soc of Nav Engs—May, 1897. No. 12912. $1.25.

LUBRICATION.

Slide Valve and Cylinder Lubrication. Editorial discussion of this subject, calling attention to defects, and a consideration of the devices in use. 1800 w. Ry Rev—May 15, 1897. No. 12951. 15 cts.

MACHINE Design.

English Practice in Machine Design. (Aus der Praxis des Maschinenbaues der Engländer.) An interesting review of the differences between English and Continental practices, by an Austrian engineer resident in England. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 16, 1897. No. 12721. 30 cts.

MOTOR Carriage.

The Columbia Electric Motor Carriage. Illustrated detailed description. 3300 w. Elec Wld—May 15, 1897. No. 12944. 15 cts.

OMNIBUS.

The Weidknecht Steam Omnibus. (L'Omnibus à Vapeur Système Weidknecht.) Illustrated description of the motor omnibus now in operation on the *boulevard extérieur* in Paris. A speed of 7½ miles an hour is obtained at a cost of 15 pounds of coke per mile. 2000 w. Le Génie Moderne—April 15, 1897. No. 12739. 30 cts.

PISTOL.

The New Recoil Pistol. (Der Neue Pistole Rückstosslader.) A paper by H. Mauser upon a new magazine pistol which is reloaded automatically by the action of the recoil. Details fully illustrated. 3500 w. Zeitsch d Ver Deutscher Ing—May 1, 1897. No. 12711. 30 cts.

PRESSURES.

An Apparatus for Accurately Measuring Pressures of Ten Thousand Pounds per Square-Inch and Over. D. S. Jacobus. Brief illustrated description. 300 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13058. 45 cts.

PUMPS.

About Steam Pumps. Thomas Shelton. Extract from a lecture before an engineer's association discussing the various kinds and their valves. 1800 w. Bos Jour of Com—May 15, 1897. No. 12885. 15 cts.

PYROMETER.

The Actinometric Pyrometer. (Pyromètre Actinométrique). A description of the Latarche pyrometer, which measures the difference in temperature by observing the effect of radiant heat upon two thermometers with silvered and blackened bulbs, respectively. 1000 w. La Revue Technique—April 10, 1897. No. 12732. 45 cts.

RECORDER.

A Pocket Recorder for Tests of Materials. Gus C. Henning. Describes an instrument designed to be used on any and all machines which have a running poise weight, without causing delay for adjustment, the results at the same time being reliable, and such that they can be at once interpreted. Ill. 2500. w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13050. 45 cts.

REVOLVERS.

The Manufacture of the Colt Navy Revolver, Model 1895. Describes the revolver and the manufacture of the several parts, especially the operations that are novel. Ill. 3000 w. Ir Age—May 27, 1897. No. 13120. 15 cts.

STEAM Plant.

The Operation of a High-Pressure Multiple-Expansion Steam Plant. Frederick L. Ray. Discusses the boiler appliances and engine of a steam-heating plant. 4000 w. St Ry Rev—May 15, 1897. No. 12958. 30 cts.

TRAFFIC.

Motor Traffic. Technical Considerations. Sir David Salomons. The subject of self-propelled traffic is discussed and the writer thinks benzine motors probably have the advantage. Steam promises to be the power when real work is called for and electric energy has a great field in towns as a luxury. Also discussion. 15400 w. Jour Soc of Arts—May 14, 1897. No. 13096. 30 cts.

WATER Wheels.

Care of Water Wheels. Points out how wheels are destroyed and suggests points needing attention. 2000 w. Lord's Mag—June, 1897. No. 13248. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

BREAKER.

A Welsh Coal Breaker. Illustrated description of the anthracite coal breaker at the Glyncastle colliery, South Wales. 1100 w. Col Eng—May, 1897. No. 12973. 30 cts.

COALFIELD.

The Hougay and Hatou Coalfield (Tonkin).

F. Brard. Describes the coal and method of mining. 1200 w. Col Guard—April 30, 1897. No. 12692. 30 cts.

COAL Handling.

Modern Methods of Handling and Storing Coals. F. D. Marshall. Read at meeting of Inst of Gas Engs., London. Describes machinery for discharging the bulk of the coals from steamers and storing the same. Discussion. 4200 w. Gas Wld—May 8, 1897. No. 12991. 30 cts.

The Treatment of Coal. Summary of an interesting discussion on two papers read at meeting of Inst. of Civ. Engs. "Tipping and Screening Coal" by James Rigg and "The Surface Plant at Kirkby Colliery" by Thomas Gillott. Ill. 6500 w. Col Guard—May 21, 1897. No. 13208. 30 cts.

COKE.

Report of the Westphalia Coke Syndicate for 1896. (Geschäftsbericht des West fälischen Kokssyndkats für das Jahr 1896.) A very full tabular report of the coke industry in its German headquarters with graphical diagrams of the relative production in Germany and the rest of the world. 7500 w. 2 plates. Glückauf—April 17, 1897. No. 12787. 30 cts.

COLORADO.

Colorado's Oil and Coal Fields. C. L. Hall. Description of the region about Florence, Col. 3500 w. Min Ind & Rev—May 20, 1897. No. 13110. 15 cts.

ELECTRICITY.

Electricity in Coal Mining. Harry N. Gardner. Illustrated description, showing the economical results of applying electricity to mining purposes, as exhibited in the anthracite mines of the New York and Scranton Coal Co., located at Peckville, Pa. 2800 w. Elec Eng—May 5, 1897. No. 12627. 15 cts.

FANS.

The Design and Testing of Centrifugal Fans. Hammersley Heenan and William Gilbert. Read before the Inst. of Civ Engs., London. A record of experiments made by the authors on several of the best known varieties of fans in use, for the object of finding the best type of fan and obtaining data whereby the proper diameter of the standard fan and its most economical speed could be determined for any required output of air at a given pressure. 6500 w. Jour Am Soc of Nav Engs—May, 1897. No. 12913. $1.25.

The Design and Testing of Centrifugal Fans. A summary of the discussion of a paper on this subject, by Hammersley Heenan and William Gilbert. 8500 w. Col Guard—April 30, 1897. No. 12689. 30 cts.

The Design and Testing of Centrifugal Fans. Correspondence arising from the paper on this subject, by Messrs Heenan and Gilbert, read before the Inst. of Civil Engs. 5400 w. Col Guard—May 9, 1897. No. 12904. 30 cts.

FIREDAMP.

Study of Firedamp Composition. From the Annales des Mines. Investigation to ascertain whether firedamp does not contain a small quantity of other gases, beside methane, equally combustible. 2000 w. Col Guard—May 7, 1897. Serial. 1st part. No. 12903. 30 cts.

HYGROMETRIC Properties.

Hygrometric Properties of Coals. R. C. Carpenter. Describes investigations undertaken to ascertain the relative qualities of various coals with reference to absorbing moisture from the atmosphere. 800 w. Trans Am Soc of Mech. Engs—Vol. XVIII. May, 1897. No. 13048. 45 cts.

KIRKBY.

The Surface Plant at Kirkby Colliery. Thomas Gillott. Read before the Inst. of Civ. Engs., England. Illustrated detailed description. 2800 w. Col Guard—May 14, 1897. No. 13070. 30 cts.

LIGNITE.

The Mining and Utilization of the Rhenish Lignites. (Die Gewinnung und Verwertung der Braunkohle im Rheinlande.) Giving several designs of successful furnaces for burning these low grade fuels without previous preparation. 1200 w. Zeitschr d Ver Deutscher Ing—April 3, 1897. No. 12701. 30 cts.

PRODUCTION.

Coal Production in 1896. Statistics as recently published by Messrs. Adler & Ruley, of Philadelphia, are given, with remarks. 800 w. RR Gaz—May 28, 1897. No. 13149. 15 cts.

SCREENING.

Tipping and Screening Coal. James Rigg. Read before the Inst. of Civ. Engs. These processes are considered separately and the methods illustrated. 5000 w. Col Guard—April 30, 1897. No. 12691. 30 cts.

SILESIA.

The Witkowitz Coal Mines at Petrzkowitz, in Prussian Silesia. (Der Witkowitzer Steinkohlengruben in Petrowitz, Preussische-Schlesien.) A descriptive account of these important coal mines, with map. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 17, 1897. No. 12775. 30 cts.

WASHER.

Wunderlich Coal Washer. From Glückauf. Gives vertical section and describes a washer by which the mineral, uniformly fed in, is separated into clean coal, shaly coal, and stone, according to the specific gravity. 900 w. Col Guard—April 30, 1897. No. 12690. 30 cts.

COPPER.

BESSEMERIZING Mattes.

Standard Practice in Bessemerizing Copper Mattes. C. W. Parsons. The article is limited to the practical details of converter work with particular reference to a 5 ft. x 8½ ft. upright converter. 2500 w. Eng & Min Jour—May 15, 1897. No. 12946. 15 cts.

GOLD AND SILVER.

ASSAY.

Anyone Can Assay. Alex. Roy. Describes an easy method of making a test for gold. 900 w. Can Eng—May, 1897. No. 12832. 15 cts.

ASSAY-MUFFLE.

An Improved Assay-Muffle. Arthur S. Dwight. Calls attention to an improvement on the method of temperature-regulation, which has been in use in the assay department of the Colorado Smelting Co., at Pueblo, and was devised by Howard F. Wierum, with the co-

operation of F. L. Capers. 1000 w. Trans Am Inst of Min Engs—May, 1897. No. 13163. 45 cts.

BOLIVIA.

The Tipuani Gold-Fields of Bolivia. William C. Agle. An account of the mines of this region and the great resources of the country. 1400 w. Eng & Min Jour—May 29, 1897. No. 13181. 15 cts.

BRITISH COLUMBIA.

British Columbia—The Big Bend District, West Kootenay. Frank L. Nason. Descriptive of the country, the mining claims already located, and the prospecting that has been done. 2400 w. Eng & Min Jour—May 8, 1897. No. 12651. 15 cts.

CANADA.

The Occurrence of Gold Ores in the Rainy River District, Ontario, Canada. William Hamilton Merritt. Describes the general characteristics of the rocks, veins, &c., with the opinion of the writer that as large a proportion of paying gold mines will be found in this region, as are found on an average in successful mining districts. Ill. 2800 w. Trans Am Inst of Min Engs—May, 1897. No. 13174. 45 cts.

COLORADO.

Geology of the Four-Mile Placer Mining Districts, Colorado. Herbert C. Hoover. The geology, method of deposition, and origin of gravel and the gold are discussed. 1900 w. Eng & Min Jour—May 22, 1897. No. 13038. 15 cts.

COLORADO River.

The Gold Belt of the Lower Colorado River. Taylor D. MacLeod. A brief review of the conditions of this district and the values in gold as found in the better-known prospects and mines. 2500 w. Min & Sci Pr—May 8, 1897. No. 12864. 15 cts.

CONCENTRATION.

Some Colorado Concentration Methods. Ph. Rearden. Suggestions from the extensive experience of the writer. 1200 w. Min & Sci Pr—May 15, 1897. No. 12978. 15 cts.

CONCENTRATORS.

Nature's Concentrators. Alfred C. Lane. Traces the analogy between the natural and artificial processes, and draws conclusions therefrom. 2800 w. Eng & Min Jour—May 29, 1897. No. 13180. 15 cts.

CYANIDE.

The Cyanide Patent. G. Massey. Particulars prepared for the benefit of a meeting to take steps to contest the amendment of the cyanide patent. Claiming the right of free use of the dilute solution of cyanide for the extraction of precious metals. 2200 w. Aust Min Stand—April 8, 1897. No. 12849. 30 cts.

GOLD Ores.

Free Milling and Chlorination of Gold Ores at North Brookfield, Queen's County, N. S. A detailed description of this new plant, which has cost over $80,000, and the process used. 2000 w. Can Min Rev—May, 1897. No. 13246. 30 cts.

GEORGIA.

The Villa Rica Mining District, Georgia. W. M. Brewer. Report from personal examination of this district, giving the properties purchased since 1895. 1000 w. Eng & Min Jour—May 15, 1897. No. 12947. 15 cts.

GOLD Field.

The Great Northern Gold Field. Almarin B. Paul. Information of the mining region of northern California and northern Oregon. 1200 w. Min & Sci Pr—May 1, 1897. No. 12666. 15 cts.

HAHN'S Peak.

Hahn's Peak Mining Region. Marshall Draper. A description of some of the geological features of one of the newest Colorado mining camps. 1800 w. Col Eng—May, 1897. No. 12974. 30 cts.

MEXICO.

The Mineral District of Hidalgo del Parral, Mexico. S. E. Gill. Describes the region and the operations of the leading company. 900 w. Eng & Min Jour—May 22, 1897. No. 13037. 15 cts.

ONTARIO.

The Mines of Ontario. J. F. Whitson. Read before the Assn. of Ontario Land Surveyors. Information gathered during two years of active exploration. 2000 w. Can Eng—May, 1897. No. 12833. 15 cts.

PERU.

The Gold Fields of Sandia, Peru. H. Tweddle. Illustrated description and historical account, giving the geological formation, deposits, workings, etc. Part first treats of Poto, and San Juan del Oro. 2800 w. Eng & Min Jour—May 8, 1897. Serial. 1st part. No. 12650. 15 cts.

RICO, Colorado.

The Enterprise Mine, Rico, Colorado. T. A. Rickard. Gives the history of the discovery, describes the rock, ore-occurrence, veins, cross-veins, &c. Ill. 13500 w. Trans Am Inst of Min Engs—May, 1897. No. 13165. 45 cts.

SECONDARY Minerals.

The Formation of Secondary Minerals in Ore Bodies. E. Moriarty Weston. Notes on their occurrences on the west coast of Australia and elsewhere. 2400 w. Aust Min Stand—March 18, 1897. No. 12652. 30 cts.

SMELTING.

A Modern Silver-Lead Smelting-Plant L. S. Austin. Discussion of Mr. Austin's paper by Henry A. Vezin. Argues in favor of works on a level, considering the good ventilation worth the extra cost, and discusses related subjects. 2700 w. Trans Am Inst of Min Engs—May, 1897. No. 13164. 45 cts.

SORTING.

Sorting before Sizing. Robert H. Richards. Describes investigations made in studying this question, with data upon the laws defining the water-quantity and slope-angle best adapted for the treatment of the different slime-sorts upon slime-tables. 5000 w. Trans Am Inst of Min Engs—May, 1897. No. 13175. 45 cts.

SOUTH AUSTRALIA.

The Arltunga Goldfield, South Australia. H. T. L. Brown. Extract from a recently issued report of this new field. Map. 4300 w. Aust Min Stand—March 25, 1897. Serial. 1st part. No. 12845. 30 cts.

SOUTH DAKOTA.

Notes on the Northern Black Hills of South Dakota. Persifor Frazer. An examination of

the geology of this region, with microscopical examination of the concentrates, and description of the Coletta group of mines. 8400 w. Trans Am Inst of Min Engs—May, 1897. No. 13173. 45 cts.

STAMP Mills.

Gravitation Stamp Mills for Quartz Crushing. D. B. Morison. Read before the North-east-Coast Inst. of Engs & Shipbuilders, Newcastle-upon-Tyne. An analysis of the mechanics of the gravitation stamp battery, describing some recent developments. Ill. 3000 w. Ind & Ir—May 7, 1897. Serial. 1st part. No. 12922. 30 cts.

TAILINGS.

The Loss of Gold in Waste Tailings. Henry Rosales. An account of examinations made to determine the actual loss of gold as carried away in waste tailings. 2800 w. Aust Min Stand—April 8, 1897. No. 12847. 30 cts.

TRANSVAAL.

Gold Mining in the Transvaal. (L'Exploitation Minière de l'Or au Transval.) Giving an account of the working of poor ores in *situ* by the Frasch chlorination process. The solution is circulated through the ore bed by pumping. 2500 w. La Revue Technique—April 25, 1897. No. 12735. 45 cts.

VICTORIA.

Notes on the Geology of the Victorian Coal Fields and Output. James Stirling. Describes the existing conditions of these coal fields. 1400 w. Aust Min Stand—March 18, 1897. Serial. 1st part. No. 12654. 30 cts.

The Golden Mines of Gippsland, Victoria. Describes a new field in the vicinity of the Bemm River, giving plan of mines and illustration of workings. 1300 w. Aust Min Stand—March 18, 1897. No. 12653. 30 cts.

The Reefs of the Sheep-Station Creek (Vic.). General remarks descriptive of some of the typical mines of this region. 1800 w. Aust Min Stand—March 25, 1897. No. 12844. 30 cts.

IRON AND STEEL.

AMMONIA.

The Agricultural Value of Sulphate of Ammonia from Blast-Furnaces. F. J. R. Carulla. Read at Iron and Steel Inst. The value of this product as a fertilizer for agricultural purposes, and the causes of the seeming decrease in money value. 2300 w. Gas Wld—May 15, 1897. No. 13088. 30 cts.

BESSEMER Process.

The Invention of the Bessemer Process. Joseph D. Weeks. Portions of the presidential address at the Pittsburg meeting, Feb., 1896, which have historical value. Ill. 3500 w. Trans Am Inst of Min Engs—May, 1897. No. 13171. 45 cts.

Presidential Address of Edward P. Martin, at Annual Meeting of Iron and Steel Institute, London. Interesting retrospect concerning the early history of the Bessemer process, a broad general survey of the present condition of the iron-making industry, with particular notice of the enormous advance in blast-furnace practice, &c. 4500 w. Col Guard—May 14, 1897. No. 13069. 30 cts.

BLAST Furnace.

The Handling of Material at the Blast Furnace. Axel Sahlin. Briefly records some of the most important steps which have been taken to solve this problem, and offers a few suggestions. Ill. 7200 w. Trans Am Inst of Min Eng—May, 1897. No. 13169. 45 cts.

CHARGING.

On Charging Open-Hearth Furnaces by Machinery. Jeremiah Head. Paper read before the Iron and Steel Inst. Illustrated description of charging machines, with discussion of their advantages. 4000 w. Engng—May 14, 1897. No. 13080. 30 cts.

CONVERTER.

The Tropenas Steel Converter. Carl Pixis. Illustrated description of a converter devised for the conversion of phosphoric or hematite pig iron into ingot iron or steel by compressed air at a low pressure. 1200 w. Eng & Min Jour—May 1, 1897. No. 12597. 15 cts.

CRUCIBLES.

On the Permeability of Steel-Melting Crucibles. J. O. Arnold and F. K. Knowles. Read before the Iron and Steel Inst., London. Experiments and results, showing the walls of the crucible form little protection against the absorption of sulphur by the metal inside. Discussion follows. 6000 w. Ir & St Trds Jour—May 15, 1897. No. 13133. 30 cts.

The Manufacture and Care of Crucibles. John A. Walker. Read before the American Foundrymen's Assn. A brief account of crucibles and crucible making, also discussing how they should be cared for, and the causes of failure. 2500 w. Ir Age—May 20, 1897. No. 12961. 15 cts.

CUPOLAS.

See same title under Mechanical Engineering, Shop and Foundry.

FORTIFICATIONS.

Iron Fortifications. Illustrates a system of iron fortifications invented by James Acton Miller of New Haven, Conn. 1500 w. Ir Age—May 20, 1897. No. 12960. 15 cts.

GERMANY.

The Iron Ore Deposits of Germany. A. Kowastch. Calls attention to rapidly approaching exhaustion of many of the oldest mines, and recommends Germany as a market for southern ores. 1500 w. Tradesman—June 1, 1897. No. 13249. 15 cts.

HARDENING of Steel.

The Hardening of Steel. Henry M. Howe. Remarks in the discussion of the paper of Mr. Sauveur on "The Microstructure of Steel and the Current Theory of Hardening." 6400 w. Trans Am Inst of Min Engs—May, 1897. No. 13170. 45 cts.

HEAT TREATMENT.

Notes on the Heat Treatment of Iron and Steel. Harry E. Smith. Considers some of the characteristics which a piece of tool or cast steel can be made to assume by the application of heat. Outlines some of the physical and chemical changes. 3000 w. Eng's Year Book, Univ of Minn—1897. No. 13005. 45 cts.

IRON Trade.

See Economics and Industry, Commerce and Trade.

MAGNETISM.
See Electrical Engineering, Miscellany.

MELTING and Mixtures.
Melting Iron and Control of Mixture. James A. Beckett. Read at the Detroit Convention of the American Foundrymen's Assn. Discusses the melting of iron by the use of the Victor Colliau cupola, and begins the consideration of mixtures in part first. 3500 w. Ir Trd Rev—May 27, 1897. Serial. 1st part. No. 13143. 15 cts.

MICROSCOPE.
Microscopy and Iron Making. (Mikroskopie und Betrieb.) Showing the use of the microscope in investigating blast-furnace work in actual work, with reproductions of micro-photographs. 6000 w. Stahl und Eisen—April 15, 1897. No. 12782. 45 cts.

NICKEL Steel.
Nickel Steel as an Improved Material for Boiler-Shell Plates, Forgings and Other Purposes. The advantages of nickel steel, with tables of comparison. 1000 w. Engng Mech—May, 1897. No. 13023. 30 cts.

OPEN-HEARTH.
Notes on the Practice of the Combined Open-Hearth Process of Messrs. Bertrand and Thiel. E. Bertrand. Describes a series of experimental heats, with general results given in tabulated form, and discusses the work. Discussion follows. Read at Iron and Steel Inst., London. 10000 w. Ir & St Trds Jour—May 15, 1897. No. 13134. 30 cts.

PAINTING Iron.
See Architecture and Building, Construction and Design.

PHOSPHORUS.
Notes on the Determination of Insoluble Phosphorus in Iron-Ores. Charles T. Mixer and Howard W. Dubois. Describes experiments made with the purpose of determining either the total phosphorus or the insoluble phosphorus by itself. 1400 w. Trans Am Inst of Min Engs—May, 1897. No. 13168. 45 cts.

STEAM POWER.
The Economical Development and Use of Steam Power in Iron and Steel Works. E. J. Duff. Read before the West of Scotland Iron and Steel Inst. Considers where improvement may be made in the generation and application of steam power. 900 w. Ir & St Trds Jour—May 1, 1897. Serial. 1st part. No. 12863. 30 cts.

STEEL.
The Import of the Recent Development of Low Steel. (Die Bedeutung und Neuere Entwickelung der Flusseisenerzeugung.) A most valuable paper read before the Düsseldorf convention of the German Association of Iron Manufacturers by Herr Schrodter, with many important tables and diagrams. 20 00 w. Stahl und Eisen. May 1, 1897. No. 12783. 45 cts.

STRESSES.
The Effect of Alternate Positive and Negative Stresses on Iron and Steel. Thomas Gray. Experiments made on test pieces of cast-iron, wrought-iron, and mild steel, the results of which are given with autographic diagrams. 1800 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13055. 45 cts.

TENSILE Strength.
The relation of Tensile Strength to Composition in Structural Steel. A. C. Cunningham. A brief account of notable investigations made of late years, with the conclusions of Mr. H. H. Campbell, with rule adopted by the author. 1500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13125. 75 cts.

WORKS.
The New Dowlais-Cardiff Iron and Steel Works. Brief history with illustrated description of plant and appliances. 4000 w. Ir & Coal Trds Rev—May, 21, 1897. No. 13160. 30 cts.

YIELD POINT.
The Yield Point of Iron and Steel. Thomas Gray. Describes the diagrams of a few tests bearing on the peculiar behavior of iron and steel as they pass through the yield point. 1600 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13056. 45 cts.

MINING.

ANTHRACITE.
Anthracite Mining. Improvements proposed by G. M. Williams, inspector of the 4th Anthracite Dist. A review of old methods, and a plan offered for future workings, which he thinks will result in increased economy and safety. 1800 w. Col Eng—May, 1897. No. 12975. 30 cts.

COMPRESSED Air.
See Mining Purposes, under Mechanical Engineering, Compressed Air.

LAMPS.
Guichot Self-Lighting Safety Lamps. M. Chesneau. From a report to the French fire-damp commission. Experiments made to test two re-lighting safety lamps; an oil lamp with match lighter, and petroleum-spirit lamp with fulminating lighter. Ill. 1100 w. Col Guard—May 21, 1897. No. 13207. 30 cts.

MINE Fire.
The Fire in the Sunday Creek Coal Company's Mine No. 10. Edward H. Coxe and C. H. Thompson. An account of the cause, and manner of fighting a fire. 3200 w. Eng & Min Jour—May 22, 1897. No. 13039. 15 cts.

SUBSIDENCE.
The Subsidence of Railway Tracks and Other Structures Located Over Mine Excavations. John Keay. Explains the system of working mines, quotes legal decisions and principles relating to surface support in this and other countries. Ill. 4000 w. Eng News—May 27, 1897. No. 13136. 15 cts.

VENTILATION.
Alluvial Mines Ventilation. A. Robertson. The manner of working is described and the best means of ventilating. 1200 w. Aust Min Stand—April 8, 1897. No. 12848. 30 cts.

Ventilation of Mines. J. Sharpe. Discusses natural, artificial and mechanical ventilation. 2000 w. Aust Min Stand—April 8, 1897. No. 12846. 30 cts.

MISCELLANY.

ALUMINUM Works.
The Aluminum Works at Foyers. Illus-

trated description of the engineering features. 2800 w. Elec Rev, Lond—May 14, 1897. No. 13085. 30 cts.

ASBESTOS.

Asbestos and Asbestic: With Some Account of the Recent Discovery of the Latter at Danville in Lower Canada. Robert H. Jones. Its nature and historical relations; its adaptations and extensive use; with description of asbestic, &c. Also discussion. 11700 w. Jour Soc of Arts—April 30, 1897. No. 12818. 30 cts.

BORING.

A New System of Boring. (Ueber ein Neues Bohr System.) An account of Fauck's apparatus for deep rock boring. The impact tool is operated at the end of a cord, the blows being given by a specially designed and illustrated mechanism. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—April 9, 1897. No. 12719. 30 cts.

CEMENT.

The Cement Materials of Southwest Arkansas. John C. Branner. Information concerning the chalk and clay-beds, gained by a visit to the localities. Ill. 6200 w. Trans Am Inst of Min Engs—May, 1897. No. 13172. 45 cts.

CHROMITE.

The Chromite-Deposits on Port au Port Bay, Newfoundland. George W. Maynard. The discovery, location and original investigations, with statement of results. 1600 w. Trans Am Inst of Min Engs—May, 1897. No. 13166. 45 cts.

DIAMONDS.

The South African Diamond Mines. William F. Booth. A brief sketch of their history and development, and how the gems are obtained from the clay. Ill. 1400 w. Col Eng—May, 1897. No. 12972. 30 cts.

FLAWS.

The Detection of Flaws by the Schiseophone. (Le Schiséophone.) This is a modification of the microphone by means of which flaws in metal are detected by the modification produced in the sound of tapping as heard in the microphone. 1000 w. Le Génie Moderne—May 1, 1897. No. 12740. 30 cts.

GAS Producer.

Notes on Some Recent Forms of Gas Producer. A. H. Sexton. Jour. of the West of Scotland Iron and Steel Inst. Calling attention to some new forms of producer for which great advantages are claimed. 2000 w. Am Mfr & Ir Wld—May 7, 1897. No. 12655. 15 cts.

MELTING Points.

Relations Between the Melting Points and the Latent Heats of Fusion of the Metals. Joseph W. Richards. A collection of data, pointing out the limits of the relation, with observations. 900 w. Jour Fr Inst—May, 1897. No. 12648. 45 cts.

METAL Mines.

Characteristic American Metal Mines. J. Wyman Jones. Describing the plant of the St. Joseph Lead Company. Ill. 1800 w. Eng Mag—June, 1897. Serial. 1st part. No. 13259. 30 cts.

The Mineral and Metal Production of the United States in 1896. A full and corrected statement of the output of the mines and metallurgical works of the United States for the last year, with their values. 4400 w. Eng & Min Jour—May 29, 1897. No. 13179. 15 cts.

PHOSPHATES.

Phosphates in Tennessee. H. D. Ruhm. Interesting survey of present operation in the new field. 2200 w. Mfrs Rec—May 28, 1897. No. 13132. 15 cts.

SALTPETER.

Our Saltpeter Caves in Time of War. Horace C. Hovey. Describes what was once a vital industry of the United States, though now abandoned, and the importance of these deposits in time of war. 2000 w. Sci Am—May 8, 1897. No. 12642. 15 cts.

TELLURIUM.

The Purification of Crude Tellurium. (Ueber die Reinigung des Rohtellurs.) A review of past and present methods by the director of the Vienna Assay Office. 3500 w. Oesterr Zeitsch f Berg u Hüttenwesen—April 24, 1897. No. 12776. 30 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.

Acetylene at the Agricultural Show. (Au Concours Agricole, L'Acétylène.) Describes several portable generators for household production of acetylene gas from calcium carbide. 2000 w. Le Génie Moderne—May 1, 1897. No. 12742. 30 cts.

See also title "Accidents" under Economics and Industry, Labor.

ARTIFICIAL Light.

See Electrical Engineering, Lighting.

BY-PRODUCTS.

Recovery of By-Products from Gas-Purifying Matter. Dr. Auerbach. Read before the Assn. of Rhenish Gas and Water Engineers. Considers the nature of the gas which enters the purifiers, the nature of the mass serving for purification, and the treatment of the purifying matter during use. 1600 w. Am Mfr & Ir Wld—May 14, 1897. No. 12890. 15 cts.

CARBURATION.

The Carburation of Coal Gas. Charles E. Botley and C. F. Botley. Read before the Inst of Gas Engrs. London. A statement of the napthalene difficulty at Hastings, and the method of overcoming it, giving an account of the investigations. Appendix and discussion follow. 16000 w. Gas Wld—May 8, 1897. No. 12990. 30 cts.

COAL GAS.

The Self-Enrichment of Coal Gas. Mr. Shadbolt. Résumé of a former paper and the results of further experiments, followed by discussion. Read at Peterborough, Eng., before Eastern Counties' Gas Mgrs. Assn. 3800 w. Gas Wld—April 24, 1897. No. 12619. 30 cts.

CURBS.

Gasholder Curbs. John P. Leather. Calcu-

lation of strains. 1600 w. Gas Wld—April 24, 1897. Serial. 1st part. No. 12617. 30 cts.

CYANOGEN.

Notes on Cyanogen as a Gas-Works Residual. G. P. Lewis. Read before the Inst. of Gas Engs., London. Considers cyanogen compounds, recovery from crude gas, extraction from spent oxide, &c., with discussion. 10000 w. Gas Wld—May 8, 1897. No. 12989. 30 cts.

FLAME.

The Luminosity of Flame. A. Smithells. Read before the Inst. of Gas Engs., London. States the difficulties relating to the study of flames, the chemical and physical character of soot, how carbon is set free in flames, cause of the glow of the separated carbon, &c. Discussion. 5500 w. Gas Wld—May 8, 1897. No. 12988. 30 cts.

GAS.

A Means of Largely Increasing the Summer Sendout of Gas. J. C. Lord. Read at meeting of Texas Gas and Elec. Light Assn. The writer's experience is given, followed by discussion. 4200 w. Am Gas Lgt Jour—May 10, 1897. No. 12700. 15 cts.

Selling Gas. I. C. Copley. Read at meeting of Western Gas Assn. The writer enumerates the conditions he considers essential, and considers the sale of gas for fuel. Discussion. 9400 w. Pro Age—June 1, 1897. No. 13188. 15 cts.

GAS Engineering.

Inaugural Address before the Institution of Gas Engineers, England. Corbet Woodall. The range and diversity of the lines of gas engineering practice, the progress, &c., with favorable remarks on inclined retorts and carburetted water gas. 6000 w. Gas Wld—May 8, 1897. No. 12987. 30 cts.

Presidential Address of J. T. Jolliffe, before Eastern Counties Gas Managers' Association. Considers temperature effects, coke and ammonia, manufacture, condensation, purification, fittings and incandescent lighting. 4800 w. Gas Wld—April 24, 1897. No. 12618. 30 cts.

GASHOLDERS.

The Influence of Wind on Gasholders. M. Irminger. An account of experiments made by the writer with results. 2600 w. Jour Gas Lgt —May 4, 1897. No. 12850. 30 cts.

GAS Producer.

See Mining and Metallurgy. Miscellany.

GAS Purification.

The use of Lime for Gas Purification. S. Carpenter. An article written for young gas managers. Directions, with explanation of the effect, suggestions pointing out the proper method of using the different agents so as to produce beneficial results. 1600 w. Jour Gas Lgt—April 27, 1897. No. 12663. 30 cts.

GAS Works.

Newcastle-under-Lyme Corporation Gas Works. F. A. Winstanley. Description of works and plant. 1800 w. Gas Eng's Mag—May 10, 1897. No. 13131. 30 cts.

The Amsterdam Gas Works. Henry H. Salomons. Read before the Inst. of Gas Engs., London. Description of the works. 3500 w. Gas Wld—May 8, 1897. No. 12993. 30 cts.

GOVERNORS.

Automatic Gas-Station Governors. Henry O'Connor. Read before the Soc. of Engs., England. Describes the duty which the gas governor is called upon to perform, with the more recent gas governors in use. 7000 w. Jour Gas Lgt—May 4, 1897. No. 12851. 30 cts.

Automatic Gas-Station Governors. The discussion of Mr. O'Connor's paper. 4000 w. Jour Gas Lgt—May 11, 1897. No. 12977. 30 cts.

ILLUMINATION.

See Electrical Engineering—Lighting.

MAINS.

Locating, Determining and Laying of Street Mains and the Distribution of Gas. J. P. Gill. Part first is largely preliminary remarks calling attention to important points. Also considers the survey of the town or city in which it is proposed to build gas works. 3000 w. Am Gas Lgt Jour—May 3, 1897. Serial. 1st part. No. 12602. 15 cents.

MEETING.

North of England Gas Managers' Association. An account of the half-yearly meeting at Newcastle. President's address, abstracts of papers and discussions, &c. 5800 w. Jour, Gas Lgt—April 27, 1897. No. 12664. 30 cts.

OXIDE.

The Value of Spent Oxide. Dr. Auerbach. Summary of paper read at meeting of the Assn. of Mid-Rhenish Gas and Water Engs. Discusses the quality of gas entering the purifier. the conditions of the purifying material, and the treatment of the material during use. 1600 w. Jour Gas Lgt—May 11,1897. No. 12976. 30 cts.

PUBLIC Lighting.

Incandescent Burners for Public Lighting. Summary of report of Thomas H. Nesbit. The data given were collated from replies obtained to a circular letter. 4500 w. Gas Wld—May 22, 1897. No. 13185. 30 cts.

RETORTS.

A Study of Inclined Retorts in Europe. Frederick Egner. Read before the Western Gas Assn. Observations gathered on a trip through England, France, Germany and Austria, made with the object of studying the "Inclined" or "Sloping" retorts. Discussion. 5000 w. Pro Age—June 1, 1897. No. 13190. 15 cts.

REVIVIFICATION.

Revivification of Oxide of Iron in Purifiers. Isaac C. Baxter. Read at meeting of Western Gas Assn. The methods are discussed and the advantages stated. Discussion follows. Ill. 5800 w. Pro Age—June 1, 1897. No. 13187. 15 cts.

SEPARATOR.

An Oil-Tar Separator and Its Results. J. R. Lynn. Read before the Western Gas Assn. Illustrated description of the apparatus used by the Detroit Gas Co.—and the results. Discussion. 5700 w. Pro Age—June 1, 1897. No. 13189. 15 cts.

VIENNA.

Gas-holder and Retort-house of the Vienna

Gas-Works. (Gas Behältergebäude und Ofenhaus der Wiener städt. Gaswerke.) Description and plates of the pretentious architecture of these important works. 2500 w. and 2 plates. Wiener Bauindustrie Zeitung—April 8, 1897. No. 12785. 45 cts.

SEWERAGE.

DRAINAGE.
Karachi Municipal Drainage Scheme. J. Strachan. Plan showing the position of various works connected with this scheme, with report of the work of the sewerage farm. 500 w. Ind Engng—April 3, 1897. Serial. 1st part. No. 12806. 45 cts.

FILTER Beds.
Operation of the Sewage Filter Beds of Brockton, Mass., in 1896. Information abstracted from report of F. Herbert Snow, city engineer. 2300 w. Eng News—May 20, 1897. No. 12995. 15 cts.

SEWER Flushing.
Systems of Sewer Flushing and Suggestions on Flush-Tank Design and Construction. Andrew Rosewater. An analysis of the relative merits of the various methods of flushing sewers, with suggestions as to the construction, operation and care of the flushing devices in general use. 2300 w. Eng News—May 6, 1897. No. 12678. 15 cts.

SEWERS.
Sewer Outlets at Niagara Falls, Ont. Charles H. Mitchell. The novel features are illustrated and described. 1400 w. Eng News—May 13, 1897. No. 12882. 15 cts.

STORM-WATER Sewers.
A Graphical Method for Determining the Capacity of Storm-Water Sewers. Clinton S. Burns. Shows how a graphical diagram may be constructed to afford an easy means of obtaining results from the new formula proposed by W. Santo Crimp and Charles E. Bruges. 1700 w. Engng Jour—May, 1897. No. 13123. 30 cts.

TRADES-Refuse.
West Riding Rivers. The Problem of Trades-Refuse. Editorial giving successful solutions of the liquid trades-refuse problem. The case adduced refers to the woolen trade. 2200 w. Engng—May 7, 1897. No. 12899. 30 cts.

STREETS AND PAVEMENTS.

ASPHALT.
Softening Agents for the Production of Asphalt Cement for Paving and Other Purposes. Clifford Richardson. States the popular fallacies in regard to petroleum residuum, describes petroleum residuum, and gives information and results of experiments. 2000 w. Munic Engng—June, 1897. No. 13197. 30 cts.

IRON Slag.
American Iron-Slag Paving. George W. Hayes. An account of the use of this material on the roads around Lebanon, its wearing qualities, manner of laying, &c. 800 w. Munic Engng—June, 1897. No. 13198. 30 cts.

PAVING Brick.
Report of the Commission on Standard Specifications and Methods of Testing Paving Brick. Edward Orton, Jr. A brief résumé of report previously given, with additional tests and conclusions. 6000 w. Clay Rec—April 29, 1897. No. 12641. 15 cts.

SCOW.
See Marine Engineering.

STREET Cleaning.
How the Streets of Paris are Cleaned. The work of the street cleaning department is described. 2000 w. San Rec—April 30, 1897. No. 12801. 30 cts.

STREET Lighting.
Street Lighting by Electricity. F. J. Warden Stevens. The article is chiefly to show that, as the standard of illumination is increased, electric lighting comes to the fore as the cheapest and most satisfactory. 2000 w. Arch., Lond—April 30, 1897. No. 12809. 30 cts.

SYDNEY, N. S. W.
Hard-Wood Pavements in Sydney, New South Wales. R. W. Richards, in The Surveyor. A short paper with discussion. 4800 w. Ind & East Eng—April 17, 1897. No. 13013. 45 cts.

WOOD Paving.
Hard-Wood Paving. From the London "Standard." Brief account of the growth of this industry, important changes, use of Australian hard woods, &c. 1600 w. Ill Car & Build—May 7, 1897. No. 12917. 30 cts.

California Redwood for Street Pavements. Ernest McCullough. Some account of paving experiments in San Francisco, with description of the use of redwood, manner of preparation and laying. Also remarks on other kinds of pavement. 2200 w. Munic Engng—June, 1897. No. 13199. 30 cts.

WATER SUPPLY.

DAM.
The New Holyoke Water-Power Dam. Sanford E. Thompson. Describes the construction of the present wooden dam, and the repairs that have been necessary, and gives details of the new stone dam, the materials, special tests and contract work. Ill. 7000 w. Eng News—May 13, 1897. No. 12879. 15 cts.

ENGLISH Water Supplies.
Water Supply of English Cities. The water supply of London as compared with other English cities is discussed. 2000 w. Fire and Water—May 22, 1897. No. 13103. 15 cts.

FILTRATION.
Filtration at Lexington, Ky. Decaying matter accumulating in the reservoirs made filtration necessary. A mechanical filter is used with success. The aerating feature is conspicuous. Cost given. 900 w. Fire and Water—May 1, 1897. No. 12616. 15 cents.

ILLINOIS.
The Water Supplies of Illinois. An account of the survey of the waters of this state for the purpose of determining their present sanitary condition, with statement of results. Ill. 2400 w. Fire & Water—May 29, 1897. No. 13177. 15 cents.

LONDON.
The London Water Supply. Dr. Percy Frankland. The advances which have been made in knowledge of the hygienic aspects of potable water, due to the discoveries in the science of bacteriology, with facts regarding the treatment

of the London supply, and its efficiency. Discussion follows. 11000 w. Jour Soc of Arts —May 21, 1897. No. 13182. 30 cts.

NEW YORK.

The Water Supply of New York City. High praise for this metropolitan work, with information concerning the new Jerome Park reservoir. Ill. 2000 w. Sci Am—May 15, 1897. No. 12856. 15 cts.

ONE HUNDRED-FOOT Standard.

The 100-Foot Standard of Length of the Boston Water Works at Chestnut Hill Reservoir. Charles W. Sherman. A brief description with some of the problems which came up, in graduation and testing. Ill. 5000 w. Jour Assn of Engng Soc—April, 1897. No. 13015. 30 cts.

OVERFLOW.

The Arrangements and Dimensions of Overflow Pipes. (Anordnung und Bemessung des Durchmessers der Ueberlaufrohre.) Especially dealing with overflow pipes for water tanks, including cost. 2000 w. Gesundheits Ingenieur —April 30, 1897. No. 12778. 30 cts.

PUMPING.

Pumping Engines for Rotterdam. Illustrates and describes engines recently constructed for the water-works. They are of the surface-condensing triple-expansion type, with three cranks at 120 deg., each piston-rod driving a double acting pressure pump. 1600 w. Eng, Lond—April 13, 1897. Serial. 1st part. No. 12688. 30 cts.

RESERVOIRS.

Reservoirs of Rammed Béton. (Wasserbehalter aus Stampfbéton.) Describing and illustrating a roofed reservoir of béton of about 80,000 gallons capacity, at Aussig in Bohemia. 1200 w. Zeitschr d Oesterr Ing un Arch Ver—April 23, 1897. No. 12723. 30 cts.

The Jerome Park Reservoir. Description with illustrations and interesting information. 2200 w. Fire & Water—May 15, 1897. No. 12931. 15 cts.

The New Distributing Reservoir for the Water-Supply System of Minneapolis. C. H. Kendall. Description and information of the reservoir and filter plant being constructed at this city. 1700 w. Eng's Year Book, Univ of Minn—1897. No. 13012. 45 cts.

The New Reservoir for New York. From the N. Y. Sun. Interesting information in connection with the water supply of the past fifty years, and the new reservoir, which is to cost fully $10,000,000. 1400. Eng—May 8, 1897. No. 12884. 15 cts.

SANITATION.

Sanitary Problems Connected with Municipal Water Supply. W. P. Mason. Presents the dangers arising from insanitary methods, the ignorance of the general public, gives statistics of several noted epidemics and their cost, and an extended discussion of the subject. 7000 w. Jour Fr Inst—May, 1897. No. 12644. 45 cts.

RIVETED Pipe.

The Distortion of Riveted Pipe by Back-Filling. D. D. Clarke. Notes on work near Portland, Ore., with account of tests and results, which may be of service to those investigating the question of the depth of trench permissible for steel water pipe under certain conditions. Tabulated statements of tests. Ill. 2500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13124. 75 cts.

STAND-PIPES.

Leaning Stand-Pipes at Red Oak and Griswold, Ia. W. D. Lovell. Describes the two cases named and the straightening of the first. The second still stands and no further settlement has taken place. 900 w. Eng News—May 13, 1897. No. 12881. 15 cts.

TAPPING.

Making a Thirty-Six-Inch Cut in a Forty-eight-Inch Water Main. An illustrated account of work accomplished by the Smith tapping apparatus. 1000 w. Fire & Water—May 8, 1897. No. 12829. 15 cts.

VALVE.

The Liebenow Water Valve. (Das Liebenowsche Nebenschlussventil.) An auxiliary valve to be used in connection with water meters to prevent the "water hammer" action and reversal of current. Its use shows a marked increase in accuracy of the meters. 3000 w. Zeitsch d Ver Deutscher Ing--April 3, 1897. No. 12702. 30 cts.

VIENNA.

The Works on the Vienna Water Supply. (Die Arbeiten der Wienthal-wasserleitung.) An account of the four great reservoirs and filter plant now under construction, with plate of details of sand filter, and report of discussion. Five articles. 25000 w. Zeitscher d Oesterr Ing u Arch Ver—April 16, 24, 30, and May 7 and 14, 1897. No. 12720. $1.50.

WATER Meters.

Water Meters. Joseph B. Rider. Examples are given aiming to show that a universal meter system is desirable, and stating its advantages. 32000 w. Fire & Water—May 29, 1897. No. 13176. 15 cts.

WATER Towers.

Some Recent Examples of Water Tower Construction. Illustrates and describes three interesting designs, located at Warren, Ill., Dwight, Ill., and Lexington, Ky., respectively. 800 w. Eng News--May 27, 1897. No. 13135. 15 cts.

WATER Works.

St. Paul Water Works. John Caulfield. Historical account, with description of sources of supply, quality of water, plant, &c. Ill. 3000 w. Fire & Water—May 29, 1897. No. 13178. 15 cts.

The New Lake Tunnel and Cribs for the Cleveland, O., Water-Works. C. F. Schulz. Illustrated description of the work begun for securing a water supply untainted by sewage for the city of Cleveland. 3000 w. Eng Rec —May 22, 1897. No. 13083. 15 cts.

The Water-Works at Hollister, Cal. C. E. Grunsky. Illustrated description, calling attention to special features. 1500 w. Eng News—May 6, 1897. No. 12677. 15 cts.

MISCELLANY.

GARBAGE Disposal.

The Vexed Question of Garbage Disposal. Rudolph Hering. Reviewing the various methods, with special attention to that of cremation.

Ill. 2800 w. Eng Mag—June, 1897. No. 13262. 30 cts.

MUNICIPAL Engineering.

Notes on Municipal Engineering Work at Salt Lake City. Details, compiled from drawings and information furnished by the city engineer. Principally details of street work. Ill. 1400 w. Eng News—May 6, 1897. No. 12680. 15 cts.

NEW YORK.

The Municipal Problem and Greater New York. Albert Shaw. Discusses the problem of municipal government, reviews the past history of New York and Brooklyn, and discusses the charter for Greater New York. Reference is made to the simplicity of the fundamental machinery of cities in other lands. 11500 w. Atlantic M—June, 1897. No. 12999. 45 cts.

REFUSE.

Electric Supply and the Destruction of Town Refuse. F. J. Warden-Stevens. Describes the usual form of destructor, and its working, showing how much heat may be obtained per pound of refuse, and how far the heat from the destructor is usable for electric supply. 2800 w. Arch, Lond—May 14, 1897. No. 13101. 30 cts.

REFUSE Destructor.

The Morse-Boulger Garbage and Refuse Destructor. Description with a statement of the new principles claimed for the system. 1000 w. Eng Rec—May 15, 1897. No. 12949. 15 cts.

STERILIZATION.

The Sterilization of Liquids in Bulk under High Pressure. (Stérilization des Liquides en Grandes Masses sous Hautes Pressions.) The Kuhn process, by means of which all decomposition or cooking of the liquid is avoided and fermentation may be arrested at any stage. 1200 w. La Revue Technique—April 10, 1897. No. 12733. 45 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

FAR EAST.

From London to the Far East by Railway. Reviews the various schemes proposed for building railways connecting the distant parts of the world, and makes remarks on the probable effect of the Trans Siberian railway. 1800 w. Engng May 14, 1897. No. 13078. 30 cts.

INDIA.

The Railway to India. C. E. D. Black. Discusses the importance, the political aspect, and physical obstructions; touching also the commercial advantages. Discussion follows. 6000 w. Jour Soc of Arts—May 7, 1897. No. 12916. 30 cts.

LANARKSHIRE.

Lanarkshire and Dumbartonshire Railway. Illustrated description of the new railway connecting the iron and coal district of Mid-Lanarkshire with the numerous shipbuilding and engineering works of the Clyde. 3500 w. Engng—May 7, 1897. Serial. 1st part. No. 12897. 30 cts.

LIGHT Railways.

Light Railways for the Cape. A summary of information collected by a commission appointed by the government, to visit and report upon the Continental and Irish systems. Favors the construction of light railways, by contract and by private companies. 1500 w. Engng—April 30, 1897. No. 12685. 30 cts.

MOUNTAIN Railway.

The Darjeeling Himalayan Railway. Illustrated brief description of an interesting construction, showing several complete loops, zigzags, and curves. 900 w. Engng—April 30, 1897. No. 12682. 30 cts.

TUNNEL.

See same title under Civil Engineering, Miscellany.

MAINTENANCE OF EQUIPMENT.

AXLE Boxes.

The Defects of Existing Axle Boxes. (Mängel der Jetzigen Achsbüchsen.) Discussion of the axle boxes of the Prussian State Railways, with interesting data about breakages, wear and lubrication. 7500 w. Glaser's Annalen—April 15, 1897. No. 12743. 45 cts.

BRAKES.

Inside Brakes for Passenger Cars. Gives the reason for adopting this plan of construction on the Canadian Pacific. 900 w. Ry Age—May 14, 1897. No. 12930. 15 cts.

The Air Brake. R. A. Parke. History of the air brake, and its evolution from straight air to automatic, from automatic to quick action, and from quick action to the modern high-speed brake, with sectional views. 5400 w. Ry Mag—April, 1897. No. 12835. 30 cts.

CABOOSE.

Caboose Car. Lake Shore and Michigan Southern Railway. Describes some new caboose cars recently built by this road, from the designs and drawings of A. M. Waitt. Ill. 900 w. Am Eng & R R Jour—June, 1897. No. 13236. 30 cts.

COAL Car.

Hopper Coal Car. Chesapeake and Ohio Railway. Illustrated description of a car of 80,000 lbs. capacity, with dimensions. 1400 w. R R Car Jour—May, 1897. No. 12823. 15 cts.

ICE Car.

Ice Car. Chicago & Northwestern Railway. Illustrated description of cars designed for this special service, but also adapted to carrying grain or coal. 600 w. Am Eng & R R Jour—June, 1897. No. 13233. 30 cts.

JAPAN.

Railways and Locomotive Building in Japan. (Eisenbahnen und Lokomotivbau in Japan.) A very fully illustrated article showing the styles and builders of locomotives shipped to Japan from Europe and America since 1871 with an account of those of native make. A most valuable article. 8000 w. Zeitsch d Ver Deutscher Ing—April 24, 1897. No. 12708. 30 cts.

LIGHTING.

Railway-Carriage Lighting. Herr H. Gerdes, in Journal für Gasbeleuchtung. Extracts giving use, cost, &c., of Pintsch gas, electricity, and acetylene. 1800 w. Gas Wld—May 1, 1897. No. 12803. 30 cts.

LOCOMOTIVE.

Express Compound Locomotive with Auxiliary Gear. Illustrated description of compound locomotive with a single pair of driving wheels, and with various constructive peculiarities. To be used on the Bavarian State Railway. 4000 w. Engng—May 21, 1897. No. 13154. 30 cts.

Compound Locomotives on the London and Northwestern Railway. Gives particulars of two experiments from the investigations made by F. W. Webb, of the performance of compound goods engines. Data supplied by the indicator and the tractometer. Also editorial. 2300 w. Eng, Lond—May 7, 1897. No. 12907. 30 cts.

Locomotive Building in Japan. Engravings illustrating the most recent achievements in the way of locomotive building by the Japanese, with dimensions and details. 1100 w. Sci Am Sup—May 22, 1897. No. 12968. 15 cts.

Ten Wheel Compound Passenger Locomotive —Northern Pacific Railway. General dimensions and description of the third design of some noteworthy locomotives recently built. Ill. 800 w. Am Eng & R R Jour—June, 1897. No. 13232. 30 cts.

The Heilmann Electric Locomotive. (Die Elektrisch Lokomotiv von Heilmann.) Detailed description of the 115 ton electric locomotive, of which design two have just been completed for the Western Railway of France. 3500 w. and 1 plate. Glaser's Annalen—April 15, 1897. No. 12744. 45 cts.

See also Street and Electric Railways.

LOCOMOTIVE Weight.

Distribution of Axle Loads. (Das Diagramm der Achselbelastungen.) Diagrams showing the distribution of the weight of a locomotive for a variety of arrangements of axles and equalizing levers. 5000 w. Glaser's Annalen—May 1, 1897. No. 12746. 45 cts.

LUBRICATION.

Lubrication of Locomotive Cylinders. Brief discussion of practice and results, with suggestions. 1300 w. Am Eng & R R Jour—June, 1897. No. 13238. 30 cts.

Economy in Engine Oil. Abstract of discussion at the April meeting of the New England R. R. Club. 2000 w. R R Gaz.—May 21, 1897. No. 12983. 15 cts.

Oiling Cylinders. Clinton B. Conger. Reviews past methods, and changes made in oiling valves and cylinders of locomotives, giving facts and observations from the writer's experience. 1800 w. Loc Engng—May, 1897. No. 12673. 30 cts.

PETROLEUM.

Petroleum Fuel on the Russian Locomotives (Chauffage au Pétrole des Locomotives des Chemins de Fer Russe.) Review of Russian official report, showing large increase in the use of petroleum refuse for locomotive firing. 3500 w. La Revue Technique—25 April, 1897. No. 12737. 45 cts.

PRIVATE Cars.

Modern Private Cars. Duane Doty. Illustrated description of the "Pioneer" and "Virginia." 1900 w. R R Car Jour—May, 1897. No. 12824. 15 cts.

Proposed Plans for Presidential Car. Illustrations of plans proposed by E. D. Nelson and Thomas Anderson, with editorial, and an article from the "Railway Agent" in criticism of the project, and other articles bearing on this subject. 3300 w. R R Car Jour—May, 1897. No. 12825. 15 cts.

RAILWAY Car.

The Queen's Railway Train. Interesting description of the particular carriage by which the Queen travels northward. 1200 w. Ill Car & Build—May 21, 1897. No. 13224. 30 cts.

RAILWAY Engineering.

Railway Engineering. Cecil B. Smith. The first of a series of papers to appear later in book form. The papers will deal chiefly with location, construction and maintenance. 3400 w. Can Eng—May, 1897. Serial. 1st part. No. 12830. 15 cts.

REPAIRS.

The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops. William Forsyth. Read before the Western Railway Club. Considers the saving that can be made by the increased capacity of old tools, and by the use of more efficient new tools. 3000 w. R R Gaz—May 14, 1897. No. 12894. 15 cts.

SPEED Indicator.

The Klose Speed Indicator. (Die Geschwindigkeitsmesser, System Klose.) An automatic recording speed indicator for locomotives which has given good results on the Northeastern Railway of Switzerland. 3000 w. Schweizerische Bauzeitung—April 24, 1897. No. 12750. 30 cts.

MAINTENANCE OF WAY.

BRIDGES.

Double-Track Swing Bridge Across the Calumet River—Chicago, Lake Shore and Eastern Railway. Illustrated description. 600 w. R R Gaz—May 7, 1897. No. 12669. 15 cts.

Swedish Railway Bridges Near the Arctic Circle. Illustrated description of bridges on a Swedish railway which is the most northerly in the world. 500 w. Eng News—June 3, 1897. No. 13253. 15 cts.

See also Civil Engineering, Bridges.

FLOODS.

Damage by the March Floods on the P. C. C. & St. L. Illustrated description of the damages on various branches of this American road. 1100 w. R R Gaz—May 14, 1897. No. 12896. 15 cts.

RAIL Joints.

The Joints of Rails. (Les Joints des Rails.) A comparison between French and Austrian practice. 3500 w. La Revue Technique—April 10, 1897. No. 12730. 45 cts.

TRACK.

Notes on Track. W. M. Cramp. Part first is introductory to a study of the proper construction and efficient maintenance of railroad track. 3000 w. Ry Rev—May 8, 1897. Serial. 1st part. No. 12843. 15 cents.

TRACK Elevation.
Track Elevation in Chicago. A general survey of the situation, with special reference to the Sixteenth Street crossing. Ill. 3400 w. Ry Age—May 28, 1897. No. 13231. 15 cts.

TRACK Improvement.
Second Track Construction and Improvement of Line and Grade from Madison to Baraboo, Wis.; Chi. & N. W. Ry. H. W. Battin. Illustrated detailed description of the work. 3500 w. Eng News—June 3, 1897. No. 13254. 15 cts.

TURNTABLE.
Locomotive Turntable Operated by Electric Motor. Illustrated description of the manner of applying an electric motor to the turntable at the West Milwaukee roundhouse of the Chicago, Milwaukee & St. Paul Railway. 800 w. Am Eng & RR Jour—June, 1897. No. 13235. 30 cts.

The Greenleaf Center-bearing Turntable. Illustrated description of turntable operated by compressed air. 1800 w. Eng News—May 13, 1897. No. 12883. 15 cts.

SIGNALING.

AUDIBLE Signal.
Boult's Audible Signal. Describes the construction and operation of an electric signalling device invented by W. S. Boult. 2700 w. RR Gaz—May 21, 1897. No. 12985. 15 cts.

BLOCK System.
Electric Block System. (Ueber Elektrische Block Anlagen.) Paper before the German Railway Society by Herr Nitschmann, describing a system including indicators by which the condition of the switches and signals is constantly in view. 5000 w. Glaser's Annalen—May 1. 1897. No. 12745. 45 cts.

INTERLOCKING.
Dolton Interlocking Plant. An illustrated description of an important plant now being built. 800 w. RR Gaz—May 28, 1897. No. 13146. 15 cts.

TERMINALS AND YARDS.

FREIGHT Terminals.
New Freight Terminals at East St. Louis—Cleveland, Cincinnati, Chicago & St. Louis Railway. Description, with general view and plans, of the new freight houses built to replace those destroyed by the cyclone of 1896. 1300 w. RR Gaz—May 7, 1897. No. 12668. 15 cts.

STATIONS.
Railroad Terminal Stations. Discusses the requirements of freight and passenger terminal stations. 2200 w. Lord's Mag—Feb., 1897. No. 12841. 15 cts.

TERMINALS.
The Proposed Improvement of the Erie Railroad Company's Terminal in Jersey City. A statement of the difficulties to be overcome, with illustrated description of a proposed method. 1600 w. RR Gaz—April 23, 1897. No. 12303. 15 cts.

TRANSPORTATION.

EARNINGS.
Railroad Earnings Show Trifling Gains. Report of April earnings, with classified tables. 3000 w. Bradstreet's—May 15, 1897. No. 12886. 15 cts.

The Quarter's Gross and Net Railway Earnings. Tabulated statements showing the tendencies of earnings of the various groups of roads for the three months of 1897 as compared with the corresponding period and entire year of 1896. 2300 w. Bradstreet's—May 22, 1897. No. 13044. 15 cts.

EMPLOYEE.
Employer and Employee. E. T. Jeffery. Address before the Y. M. C. A. of the Denver & Rio Grande. Extract. 1700 w. Ry Age—May 14, 1897. No. 12928. 15 cts.

INTERCHANGE.
Suggestions for the Revision of the M. C. B. Code of Rules. George S. Hodgins. Suggested modifications by the writer and editor. 3500 w. R R Car Jour—May, 1897. No. 12822. 15 cts.

INTERSTATE Commerce.
See Economics and Industry, Governmental Control.

MILK Rate.
The Milk Rate Decision. An abstract of the report recently issued by the Interstate Commerce Commission on rates for the transportation of milk to New York City, with editorial. 2800 w. R R Gaz—May 7, 1897. No. 12667. 15 cts.

RAILROAD Accounting.
The Physical Aspect in Railroad Accounting. Thomas F. Woodlock. Maintaining that railroad reports should show character and composition of business, and circumstances surrounding its handling. 3300 w. Eng Mag—June, 1897. No. 13257. 30 cts.

RATES.
Another Supreme Court Decision. Editorial comment on the decision that the Interstate Commerce Commission has no power to prescribe rates. 1400 w. R R Gaz—May 28, 1897. No. 13148. 15 cts.

Maximum Railway Rates. Review of a work issued by Messrs. Butterworth & Co., London on the law respecting the maximum charges for the carriage of goods by railway. 2700 w. Trans—April 23, 1897. No. 12607. 30 cts.

RATING.
Tonnage Rating of Locomotives. The method of determining the capacity of locomotives of the Southern Pacific. 1700 w. Ry Age—May 21, 1897. No. 13112. 15 cts.

TRAFFIC.
The Reorganization of the Traffic Associations. Editorial on the new agreements in process of adoption by the various associations, for the purpose of continuing all of their functions which are not contrary to law as expressed in the recent Supreme Court decision. 1100 w. R R Gaz—May 7, 1897. No. 12670. 15 cts.

Traffic Associations and the Law. A summary of the opinions of various courts on the legality of association agreements. 1800 w. Ry Age—May 7, 1897. No. 12827. 15 cts.

Traffic Statistics from Germany and Hungary. Report of railroad passenger- and freight-traffic, with comparison with American rates. 1000 w. R R Gaz—May 21, 1897. No 12986. 15 cts.

TRAIN RULES.
C., N. O. & T. P. Train Rules. Information in reference to the revised edition of the book of rules for employees in the transportation department of this road. 2000 w. R R Gaz—May 28, 1897. No. 13145. 15 cts.

TRAIN SERVICE.
The May Train Services. Charles Rous-Marten. New departures of the British railway companies. 1200 w. Eng, Lond—May 7, 1897. No. 12905. 30 cts.

TRANS-MISSOURI.
See Economics and Industry, Governmental Control.

MISCELLANY.

ACCIDENTS.
Train Accidents in the United States in April. A detailed list of the more important accidents, with classified summary and comments. 2700 w. R R Gaz—May 28, 1897. No. 13147. 15 cts.

BRITISH Railways.
British Railway Enterprise. Part first gives an idea of British railway management and construction, with illustrations of equipment. 1400 w. Can Eng—May, 1897. Serial. 1st part. No. 12831. 15 cts.

CHINA.
Railroading in China. R. Van Bergen. Interesting information of railroading prospects of this country, with the difficulties and obstacles to be met, and stating that there is no probability of Americans obtaining concessions for building railroads. 1500 w. R R Gaz—May 14, 1897. No. 12895. 15 cts.

ECONOMIES.
Recent Railway Economies. E. E. Woodman. Lecture before the Soc. of Engs. Calls attention to the extensive application of Bessemer metal to the improvement of railways, and the economies in consequence, increase of capacity of cars, growth of engines, &c. 6400 w. Eng's Year Book, Univ of Minn—1897. No. 13007. 45 cts.

ELECTRIC Traction.
Electric Traction Under Steam-Railway Conditions. Charles Henry Davis. Comparing in detail electric and steam systems of installation and operation. 6200 w. Eng Mag—June, 1897. Serial. 1st. part. No. 13260. 30 cts.

FLORIDA.
Florida's Railway Bill. A law to discourage railway investment in the state of Florida, also editorial. 3000 w. Ry Age—May 14, 1897. No. 12929. 15 cts.

NATAL.
The Remarkable Railway Year in Natal. An account of the marvelous earnings of the government railways as given in their report and from interview with Mr. David Hunter, the general manager. 1500 w. Trans—April 30, 1897. No. 12808. 30 cts.

RAILWAYS.
Railways of the World. A review of the last seventy-two years. 1800 w. Sci Am Sup—May 22, 1897. No. 12969. 15 cts.

The People and Their Railways. E. T. Jeffery. An address before the annual convention of the interstate commerce commission and the boards of state railway commissioners held in St. Louis. 9500 w. Ry Age—May 21, 1897. No. 13113. 15 cts.

The Story of the Railway. The First Tracks. Early Locomotives. First of a series of articles to describe and illustrate the development of the railway. 3300 w. Ry Mag—April, 1897. Serial. 1st part. No. 12838. 30 cts.

RELIEF Departments.
Railway Relief Departments. Reviews information on this subject as presented by Mr. Emory R. Johnson, and published as Bulletin No. 8 of the Dept. of Labor, at Washington, with comments. 4000 w. Eng News—June 3, 1897. No. 13255. 15 cts.

RESISTANCES.
Train Resistances. M. Barbier, in the April issue of the Revue Générale des Chemins de Fer. Discussing the question of train resistances at high speeds. The paper is considered a valuable contribution to this subject. 2800 w. R R Gaz—May 21, 1897. No. 12981. 15 cts.

TELEGRAPH.
See same title under Electrical Engineering, Telegraphy and Telephony.

TUNNEL.
See Civil Engineering, Miscellany.

VIBRATION.
The Vibration of Railway Carriages. A. Rudolff. Brief account of tests made by the author, the observations being confined to carriages running on a well-kept road, properly coupled, uninfluenced by neighboring carriages, and situated in the center of the train. 600 w. Prac Eng—April 30, 1897. No. 12816. 30 cts.

STREET AND ELECTRIC RAILWAYS.

ACCUMULATORS.
Traction by Accumulators. An abstract of an article published in the Elektrotechnische Anzeiger, describing some experiments made with a tramcar propelled by accumulators. Ill. 1300 w. Elec Rev, Lond—May 14, 1897. No. 13086. 30 cts.

AMERICAN Practice.
Recent American Practice in Electric Railways. Louis Bell. Part first is confined to the general design and construction of power stations. Ill. 3300 w. Ry Wld—May, 1897. Serial. 1st part. No. 12939. 30 cts.

BROOKLYN.
The General Passenger Department of the Brooklyn Heights Railroad Company. II. Milton Kennedy. Ideas on methods of advertising and other means of increasing the business of street railways. Ill. 2700 w. St Ry Jour—June, 1897. No. 13192. 45 cts.

BUDAPEST.
The Underground Railway at Budapest. (Die elektrische Untergrund bahn zu Budapest.) A very complete illustrated account of the roadway and power plant of this pioneer electric underground road. Two articles. 5000 w. Schweiz-

erische Bauzeitung. April 10 and 17, 1897. No. 12748. 60 cts.

LOCOMOTIVE.

Compressed-Air Locomotive for the Manhattan Elevated Railroad. Brief illustrated description. 350 w. Am Mach—May 6, 1897. No. 12660. 15 cts.

The Hardie Compressed-Air Locomotive for the Manhattan Elevated Railroad. Illustrated description. 800 w. RR Gaz—May 21, 1897. No. 12982. 15 cts.

Electric Locomotives. J. J. Swann. Deals principally with elevated and suburban traffic. 1500 w. Sib Jour of Engng—May, 1897. No. 12962. 30 cts.

PAINTING.

Repainting Old Cars. Charles Koons. Hints and directions for the work, with introductory remarks. 2800 w. St Ry Rev—May 15, 1897. Serial. 1st part. No. 12957. 30 cts.

POWER House.

The Largest Electric Plant in the Country. Illustrated description of Power House No. 2 of the Chicago city railway. 1300 w. Power —June, 1897. No. 13155. 15 cts.

RAILS.

Continuous Rails in Unpaved Streets. Illustrations of continuous rails laid in unpaved streets, with description of construction and report of wear. 700 w. St Ry Rev—May 15, 1897. No. 12955. 30 cts.

RAPID Transit.

Electricity or Steam in Rapid Transit—Which? George Moffat. Concludes that the roads will undoubtedly be driven to use electric motors. 2000 w. Am Eng & RR Jour—June, 1897. No. 13239. 30 cts.

SAFETY Device.

Improved Safety Device for Electric Circuits. Lewis G. Rowand. Describes the writer's method of reducing the element of danger arising from this source, giving different applications of the device to meet the requirements of electric trolley circuits. Ill. 1700 w. Jour Fr Inst—May, 1897. No. 12645. 45 cts.

SPLICING.

Splicing Small Cars. W. H. Pelton. Illustrated description of the forming of one 32-ft. car from two 16 ft. cars. 1100 w. St Ry Rev —May 15, 1897. No. 12959. 30 cts.

TESTING Motors.

Some Methods of Testing Motors. Frank B. Porter. Gives some of the most useful tests that are ordinarily used by electrical engineers, and can be easily applied to the equipment of street railway motors. Ill. 1800 w. St Ry Jour—June, 1897. No. 13194. 45 cts.

THIRD Rail.

The Third Rail Equipment of the N. Y., N. H. & H. Railroad Between New Britain and Hartford, Conn. Illustrated description of a section formerly operated by steam and recently equipped for electric traction, the third rail system being used. 1800 w. Elec Eng—May 19, 1897. No. 12937. 15 cts.

THREE-WIRE System.

Improvements in the Three-wire System. Truman Hibbard. Reviews numerous patents since 1880, and the advantages gained. 4000 w. Eng's Year Book, Univ of Minn—1897. No. 13006. 45 cts.

TRACTION.

Tramway Traction. A review and criticism of the report of committee of the Corporation Tramways of Sheffield, Eng., after a trip including the principal towns of England and the Continent where different systems of tramway traction were in operation. 3500 w. Eng, Lond—May 14, 1897. No. 13071. 30 cts.

See also "Electric Traction," above.

TRAMWAYS.

The Generation of Electrical Energy for Tramways. J. S. Raworth. The object of the paper is to show that a suitable and paying price for the supply of electric energy for tramway purposes, under reasonably favorable conditions, is one penny per unit and that the said supply will reduce the cost of the lighting current by an amount which, though small, is definite. 2800 w. Elect'n—April 30, 1897. No. 12814. 30 cts.

The Huddersfield Tramways and the Municipalization of Tramways. J. Pogson. Historical account of these tramways, with short discussion. 3300 w. Elec Rev, Lond—April 23, 1897. No. 12601. 30 cts.

TRANSPORTATION.

The Progress of Transportation Improvements in Vienna in 1896. (Ueber den Fortschritt der Verkehrsaulagen in Wien in Jahre 1896.) Including a review of the street improvements, the elevated railway, and the river and canal improvements. Two articles, 3500 w. Zeitschr d Oesterr Ing u Arch Ver—May 7, 1897. No. 12728. 60 cts.

TROLLEY Car.

The Trolley Car After a Day's Run, and Its Repairs. Daniel O'Mahoney. An account of the inspection and repairs, the usual difficulties to be overcome, and the improvements made. 2000 w. Elec Eng—June 2, 1897. No. 13240. 15 cts.

UNDERGROUND Railways.

Deep Tunnel Railways for London. Editorial discussion of some of the schemes for the solution of the transit difficulties. 1800 w. Engng—April 9, 1897. No. 12228. 30 cts.

UNITED STATES.

The Financial Results of Cable and Electric Railway Operation in the United States. Part first gives a broad view of the combined street railway systems of New York, Massachusetts, and Pennsylvania. Later papers will discuss the results of individual street railway systems. 4000 w. St Ry Jour—April, 1897. Serial. 1st part. No. 12073. 45 cents.

WHEELS.

A Comparison of American and European Wheel Practice, with Notes on General Condition of Service. P. H. Griffin. The results obtained from chilled iron- and steel-tired wheels, the advantages of each, the difficulties in electric wheel service, &c. 3500 w. St Ry Jour—April, 1897. No. 12074. 45 cts.

WIRE Tension.

An Important Trolley Question. (Brennende Bahn-Fragen.) A discussion of the great tensional strains upon the trolley wires, due to changes of temperature. 1500 w. Deutsche Zeitschr für Elektrotechnik—March, 1897. No. 12456. 30 cts.

COMMENT & CRITICISM

The Creep of Rails.

THE April number of THE ENGINEERING MAGAZINE contains some extracts from a paper on "The Creep of Rails," read before the Austrian Society of Engineers.

The *résumé* of the paper, says: "In most of the roads investigated the creep was in the direction of the travel of trains and also down grades, as might be expected."

The first statement—that the creep is in the direction of the movement of trains—is not a clear expression of fact. If this be the case, then there would be no creep of the rails on a railway where the traffic was equal in either direction. As the writer happened to be an engineer on maintenance of way for about seven years, on a railway with traffic conditions that were about equal in either direction, and for a period of twelve years made a close study of evidences of creeping rails, he cannot but express his opinion that while the movement of trains upon a track may facilitate the creeping, it is not the cause; this must be looked for elsewhere.

The creep is evidently in the direction of the least resistance.

The movement of a rail under a moving load is a retroaction, inasmuch as the rail under its train-load will come down to a firm bearing, and, when relieved, will again take its normal bearing, or position, thus causing a slight deflection with each moving load it carries. If a rail in use be overturned, the tie-bearing scars will generally show a bearing mark on the rail that is somewhat wider than the tie upon which that part of the rail rested; excepting upon a grade these marks will give no evidence of creeping. There is a slight and constant deflection of rails under moving trains which is often quite perceptible, noticeably so if one will closely examine the track just in advance of a coming train. How much of this movement contributes to the creep? Very little of it, if any.

When a track is re-surfaced, it is raised an inch or more, and, no matter how well the tamping is done, there will be more or less yielding of the track under moving train-loads, after the surfacing work is completed, until the disturbed ballast bearing is again brought to compactness. This resurfacing of the track, the action of the elements, the traffic on the track, all combine to make constant changes in the general elevation of the track, producing a constant subsidence movement. In this combination of conditions the evidences of the creep in rails will be found. The elements are the cause, the traffic is the agitator, and the rails are the victims.

The greatest expansion of track of which the writer is cognizant occurred on a level track, at a bridge approach, in a valley nearly one mile wide, when some thirty cross-ties were lifted entirely from the ground and bridge-stringers. Was the sole cause of this lifting of the track the extreme heat of an August day? Were there ulterior causes affecting this stretch of level track that had more to do with it than the sun? If so, let us examine the two ridges forming the sides of the valley.

Both of the ridges were crossed through heavy cuts, and many years had elapsed since these cuts were excavated and the track laid through them. Since the track was first laid, these cuts had been treated as all railway cuts usually are; the rains and melted snow, supplemented by frost action, had sloughed off the embankment slopes, undermined the track in places, and washed away the gravel ballast, and the track had as often been repaired and put into excellent condition by the track force. Each time a large quantity of material that had been deposited in the ditches upon either side of the track within the confines of the cut was carried out. This had been done so often that the elevation of

the track at the apex of the ridge, and the distance along the face of the rails from the level track in the valley, up the ascent, to the apex of the ridge, was less than when the track was first laid. The deficiency in elevation was apparent from an examination of the original profile compared with a re-survey of the line made many years after the road was completed. While the track had apparently hung in place at the top of the ridge, as a rope would hang over a log, the traffic of the road had gradually rolled the excess in length of rails down the descent, and the level track in the valley had received it. The hot August sun had simply concentrated it.

If railway cuts were more generally sub-soil-drained, with good drain tile, there would be less mystery in the creep of rails, so far as grades are concerned; yet the subsidence of the railway embankment is another vital condition affecting rail movement.

The greatest evidence of rail movement is found at the intersection of two railways, where the grade crossing must be continually tinkered to keep it in line with both tracks.

Occasionally it is necessary to shorten a rail on one side and interpose a longer one upon the other side to hold the thing in true alignment.

This trouble with railway crossings the writer has often met with at single crossing, on long stretches of track in the rural districts; and, singular to relate, in Chicago at the stockyards crossing, where there were more than a dozen crossings in one place, he does not recall an instance in seven years when any one of them was ever forced or thrown out of line by the creep of rails; they were worn to pieces in place, by the heavy and constant traffic passing over them.

Evidently the creeping of rails is a local matter; the whole line of track does not creep bodily in one direction, as some writers would have us believe. The creep can be attributed entirely to local conditions, aided by several natural causes.

W. J. GOODHUE.

White Hill, Mohave Co., Arizona, April, 1897.

The Efficiency of Built Beams.

I have read your review of my paper on Built Beams, in your May issue, and I note the question in regard to the solitary case where an efficiency of 108.5 came out. This was not a misprint. In spite of the method of providing check pieces, differences would always be found in the strength of the different sticks cut from the same board. Usually these differences were small, but I have known them to be as much as 30 per cent. Every experimenter on timber has found the same thing. From this it seems reasonable to believe that, in the case referred to, one of the sticks, owing to variation in structure of the material in the four quarters of the beam, was considerably stronger than the check pieces, and that this stronger piece was on the tension side of the built beam, and hence gave the efficiency as 108.5. Such efficiency, was of course, rather apparent than real, but it seems best to give it, as the result was obtained in exactly the same way as the others.

I have now under way a lot more experiments on the same subject, and hope that these may clear up, at least to some extent, the very question you open.

At best, the subject is a difficult one to experiment upon with great accuracy, and I am omitting no means of getting out the most reliable results I am able to obtain, with careful study of all the details.

EDGAR KIDWELL.

Houghton, Mich., May, 1897.

A Correction.

A typographical error, creeping into Mr. A. A. Cary's article on "The Cure for Corrosion and Scale from Boiler Waters" in the May issue of THE ENGINEERING MAGAZINE, makes the instructions for preparing a standard solution of hard water (p. 232) read: "Dissolve 1.11 grains of pure fused calcium chlorid," etc., when the text should read: "Dissolve 1.11 grams of pure fused calcium chlorid."

The error, while not a large one typographically, is of course very important chemically as 1.11 grams is equal to about 17 grains.

BOOKS OF THE MONTH

Derr, Wm. L. Block-Signal Operation. A Practical Manual. D. Van Nostrand. New York. Cloth, $1.50.

Except in one particular, originality is disclaimed by the author, who states his purpose to be the presentation of the latest American and European practice in block-signal operation. The exception, however, appears to be an important one, and is a description and explanation of a method of single-track blocking comprised in Chapter X of the treatise. The author expresses full confidence that this method "will insure the holding, at the proper passing sidings, of trains to be met by opposing trains." The descriptions of apparatus employed are, for the most part, general, details being described only when thought necessary to a proper understanding of the operating rules. The assistance of a long list of prominent railway officials and engineers in supplying information is acknowledged in the author's preface. The whole forms a comprehensive review of methods, apparatus, and rules employed in present practice, illustrated by diagrams.

Greene, Thomas L. Corporation Finance. A Study of the Principles and Methods of the Management of the Finances of Corporations in the United States; with Special Reference to the Valuation of Corporation Securities. G. P. Putnam's Sons. New York. 1897. Cloth, $1.25.

The purpose of this treatise is plainly the extension of popular information upon the subject of corporation financiering, the reasons which underlie the policy pursued in the United States with reference to corporations, and the results of such policy. The author is an auditor of one of the largest trust companies in the country, and, as such, is an authority upon the subject upon which he writes. While thus adapted to the wants of the general public, the treatise is well adapted to use as a text-book in educational institutions, and even the legal profession might find in it valuable hints to be utilized in the organization and administration of corporate affairs.

Baker, M. N. The Manual of American Water Works, 1897. *The Engineering News* Publishing Company. New York. 1897. Cloth, $3.

The author (who is the associate editor of *The Engineering News*) has herein compiled from special returns the history and descriptions of the source and mode of water-supply-pumps, reservoirs, standpipes, distribution systems, pressures, consumption, revenue and expenses, cost, debt, and sinking fund, and much other practical and statistical information relating to the water works of the United States and Canada, with summaries for each State and group of States, and water rates charged in more than 1,250 cities and towns. This is the fourth issue of this annual, and, in addition to what we have above enumerated, the book comprises in its introduction an interesting essay upon "Modern Tendencies in Water Works Practice," and tabulated statements of statistical value. The division between public and private ownership in each State, and changes from public to private ownership and the reverse, are also noted.

Dixon, D. B. The Mechanical Arts Simplified. A Comprehensive Treatise on Electricity, Hydraulics, The Indicator, Ice-Making, etc. Laird & Lee. Chicago, 1867. Cloth, $2.50.

While this volume of 497 octavo pages may fairly be styled "comprehensive" in the number of subjects treated, it is scarcely so in its method of their treatment. Besides the topics named on the title page, those included by the abbreviation, etc., are numerous, diverging into architecture, steam engineering, machine-building, boiler-making, and stone, iron, and woodworking. The book (which has been revised and supplied with a new appendix for the present edition) is intended for service as a work of reference,—in fact, a sort of handbook. How well it is adapted to this purpose is indicated by the fact that it has no index, a by-no-means-inclusive table of contents being the only guide to a mass of unclassified material, collected from a wide range

of treatises, and thrown together in anything but a systematic manner. The data thus gathered are such as can be found in most good engineers' handbooks, and in a much more handy form for practical use.

Raphael, F. Charles. The Localization of Faults in Electric-Light Mains. D. Van Nostrand Co., New York. "The Electrician" Publishing Co., Limited., London. 1897. Cloth, $2.

This book will supply a lack in the literature of electric engineering; for, although the subject of the localization of faults in telegraph cables has been extensively dealt with by able writers, the analogous treatment of faults in cables used for power and lighting has been neglected, probably under the mistaken impression that the analogies between conditions in the two classes of cables are closer than they really are. The differences in conditions are so great as alone to justify an intelligent and well-directed attempt to supply this hiatus in technical literature, and compelling changes in methods, partly depending upon different modes of insulation discussed (as belonging to the subject) in Chapters II and III. A method of testing a permanently-earthed network, which the author believes has not hitherto been used, is described on pages 50 and 61. A feature of the work is the grouping of the proofs of formulæ in a single chapter, instead of distributing them throughout the text. An original investigation relating to the accuracy obtainable from a given set of instruments, and a formula (deduced from fundamental bridge equations by the method used by Kempe in his "Handbook of Electrical Testing") for finding the possible degree of accuracy, may, it is thought, prove useful in ordering testing sets. In short, the matter, method, and style of publication render this book a desirable and commendable addition to current technical literature.

Reeve, Sidney A., M.E. The Entropy-Temperature Analysis of Steam-Engine Efficiencies. Progressive Age Publishing Co. New York. 1879. Cloth, 75c.

It is now generally acknowledged by the engineering profession that the entropy-temperature analysis of steam-engine tests comprehensively answers all questions relating to steam-engine efficiencies, in a manner incomparably more elegant than that which characterizes any other method of arriving at the required data. The labor of preparing for each analysis the required curves has heretofore been objectionable, and has, doubtless, much retarded the employment of this analysis. In *Engineering* (London), January 3, 1896, Professor Boulvin, of Ghent University, presented a diagram intended to obviate much of the labor of preparing the pre-requisite curves. The form of the diagram has since been modified by Professor Reeve, to render it much more convenient and exact for general use, and this modified diagram, with full explanatory text, constitutes the work under notice. We hazard nothing by saying that this small treatise, bringing, as it does, a scientific and valuable method within the practical reach of practising engineers, is an important contribution to steam-engine literature; it should be in the hands of every student of the science and practice of steam engineering.

American Plumbing Practice. A Selected Reprint from *The Engineering Record* (prior to 1887, *The Sanitary Engineer*) of Articles Describing Notable Plumbing Installations in the United States, and Questions and Answers on Problems Arising in Plumbing and House Drainage. *The Engineering Record*. New York. 1897. Cloth, $3.

The title so well indicates the contents that, the source of the articles being also named, there is scarcely need to say more to establish the value of the work. *The Engineering Record* has long been recognized, not only in the United States but also in Europe, as one of the highest American authorities in matters of sanitary and municipal engineering, in which the topics of heating, ventilation, and drainage have always occupied a position commensurate with their importance as health factors. Its discussions of principles and descriptions of appliances, installments, and details of plumbing and heating work have notably helped in the remarkable progress of the last quarter-century in these branches of engineering. It might well be expected that from the columns of a publication which has been so ably conducted through a long period a most interesting and valuable collection

of examples of plumbing practice could be culled, and a glance through the pages of the book is sufficient to show that such an expectation will be entirely satisfied. The explanations and descriptions, accompanied, as they are, by no less than 536 illustrations, are so plain that even the apprentices in the craft can read them understandingly, while at the same time they present to the adept a complete compendium of standard American practice in an art indispensable to sanitary construction, and one of whose recent marked advance its practitioners may well be proud. The book is a quarto of 260 pages, handsomely printed and bound.

BOOKS ANNOUNCED.

Tayler, A. J. Wallis. Motor Cars; or Power Carriages for Common Roads. Imported by C. Scribner's Sons, New York. 1897. Cloth, $1.

Andrews, G. Microscopic Fractures in Steel. Spon & Chamberlain, New York. 1897. Paper, 80 cents.

Andrews, G. Microscopic Fractures in Steel Rails and Axles. Spon & Chamberlain, New York. 1897. Paper, 40 cents.

Barber, F. Walter. The Engineer's Sketch-book of Mechanical Movements, Devices, Appliances, Contrivances, and Details Employed in the Design and Construction of Machinery for Every Purpose. Spon & Chamberlain, New York. 1897. Cloth, $4.

Blaine, Rob Gordon. Hydraulic Machinery. With an Introduction to Hydraulics. Spon & Chamberlain, New York. 1897. Cloth, $5.

Fuertis, Jas. H. Water and Public Health. The Relative Purity of Waters from Different Sources. J. Wiley & Sons, 1897. Cloth, $1.50.

Glover, Jas. Formulas for Railway Crossings and Switches. A Pocket-Book of Reference. Spon & Chamberlain, New York. 1897. Limp cloth, $1.

Parker, H. C. A Systematic Treatise on Electrical Measurements. Spon & Chamberlain, New York. 1897. Cloth, $1.

Robinson, Stillman Williams. Principles of Mechanism. John Wiley & Sons, New York. 1896. Cloth, $3.

Allen, J. A. Tables for Iron Analysis. John Wiley & Sons, New York. 1896. Cloth, $1.

Austen, P. T. Notes for Chemical Students. John Wiley & Sons, New York. 1896. Cloth, $1.50.

Bazin, H. Experiments upon the Contraction of the Liquid Vein Issuing from an Orifice, and upon the Distribution of the Velocities within It. Translated by J. C. Trautwine. John Wiley & Sons, New York. Cloth, $2.

Gargoyle, Solomon. Five Sins of an Architect. Essays. Arnold & Co., Philadelphia. 1897. Buckram, $1.

Gill, A. H. Gas and Fuel Analysis for Engineers. John Wiley & Sons, New York. 1896. Cloth, $1.25.

Stallard, J. H. The Problem of Municipal Government, as Illustrated by the Municipal Government of San Francisco. Reprint from *Overland Monthly*. Overland Monthly Publishing Company, San Francisco. 1897. Paper, 50 cents.

BOOKS RECEIVED.

Statistics of the American and Foreign Iron Trades for 1896. Being the Annual Statistical Report of The American Iron and Steel Association. Presented to the members, 'une 10, 1897. The American Iron and Steel Association, Philadelphia. Paper.

Mead, Elwood. Biennial Report of the State Engineer of Wyoming for 1895–96. Paper.

Morse, W. F. Cremation. The Disposal of Waste. Improved Garbage and Refuse Destructors. Disinfection by Streaming Steam Currents under Low Pressure. Sterilization by Formic Aldehyde Gas. Published by the author, 56 and 58 Pine street, New York. Paper.

Wilson, Herbert H. Pumping Water for Irrigation. No. 1 of Water-Supply and Irrigation papers of the U. S. Geological Survey. Department of the Interior, Washington. Gov't. Printing Office, 1896. Paper.

Campbell, A. W. Report of the Provincial Instructor in Road-Making, Ontario. Ontario Department of Agriculture. 1896. Paper.

History of the Baldwin Locomotive Works from 1831 to 1897. J. B. Lippincott Co., Philadelphia. 1897. This is an interesting narrative of the rise and progress of an important American industry, as exemplified in one of the most prominent manufacturing establishments of the entire world. The magnitude of the plant is indicated by the fact that it employs 5100 men. Thirty years were employed in building the first thousand engines, but almost as many were built in the single year begining the present decade, or an average of over three finished locomotives per day. The name of the author of the book has been, for some reason, withheld.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

American Gas Furnace Company, New York. =(*a*) Pamphlet illustrated and describing the automatic fuel gas plants manufactured by this company (fifth edition). (*b*) Illustrated catalogue and price list of "Gas Blast" furnaces (fifth edition), for oil gas, illuminating gas, natural gas, etc. Illustrated pamphlet describing a new, reliable, noiseless high-pressure blower, applicable wherever a steady blast under definite pressure is needed. Six regular sizes are listed, with capacities and prices.

Hill, Clarke & Co., Boston, Mass., U. S. A.=(*a*) Important and handsome catalogue of 469 octavo pages, well and permanently bound in cloth, illustrating and describing (under the general title, "*Machinery Blue Book*") comprehensive lines of iron-working machine tools, machine-shop supplies and pattern-makers' machinery. A feature of this "Blue Book," which, we judge, probably suggested its unique title, is the delicate tinting (by means of a second impression) of the cast iron parts of the machines illustrated, thus producing a novel, striking, and beautiful effect, and clearly distinguishing the cast-iron parts from parts made of other materials. (*b*) A telegraphic code for use in connection with the "Machinery Blue Book" above described

The Pittsburg Reduction Company, Pittsburg, Pa., U. S. A.=A trade treatise on Aluminium and Aluminium Alloys. It treats largely of the chemistry and metallurgy of aluminium and its present and ever-increasing industrial applications as a material in the useful and ornamental arts. Cloth, price $1.50 (distributed free to large customers). An examination of the table of contents shows that the amount of careful labor bestowed upon the preparation of this book, more than justifies the price. A very large number of carefully-prepared and compiled data have been tabulated. Up-to-date information upon the subject of aluminium and other alloys, and methods of working these alloys as well as the pure metal, is supplied The effect upon cast iron of the introduction of aluminium is also discussed.

Buff & Berger, Boston, Mass , U. S A.=Catalogue and price list of astronomical instruments, engineers' transits and levels, and surveyors' instruments.

University of Wisconsin, Madison, Wis., U. S. A.=Catalogue for 1896–97.

Keuffel & Esser Company, New York; Chicago; St. Louis, Mo., U. S. A.=Illustrated catalogue and price lists of a leading and very extensive line of drawing materials and surveying instruments. The extent of this line may be estimated from the fact that 424 closely printed octavo pages are required to contain the price lists, illustrations, and descriptive text, making it one of the most important catalogues of this class of goods issued in the United States.

The Reeves Pulley Company, Columbus, Ind., U. S. A.=Illustrated catalogue of the "Reeves Patent Split Pulley."

Jenkins Bros., New York.=Catalogue for 1897. Illustrates and describes the long list of valves for general and special use now manufactured by this firm, inclusive of a new-comer, the "Excelsior" back pressure valve, the manufacture of which by this firm has been recently commenced.

The Rollins Engine Co., Nashua, N. H.=Elegantly-printed illustrated catalogue describing the Rollins steam engine in detail, and presenting testimonials from users.

Boston Belting Company, Boston and New York, U. S. A.=Pamphlet and catalogue of the rubber mats, matting, and treads, with illustrations of styles, descriptive text, and price-lists—an elegant trade publication.

The Goheen Manufacturing Co., Canton, Ohio, U. S. A.=Pamphlet entitled "The Ex-Rays Turned on our Sky-Scrapers"; in which is voiced public alarm at the corroded state in which the iron work of some tall buildings has been found, and in which the merits of "Goheen's Carbonizing Coating" as a protective agent for guarding iron structural work against corrosion, from atmospheric influences is discussed.

The J. W. Ruger Manufacturing Company, Buffalo, N. Y., U. S. A.=Catalogue describing and illustrating gas engines, and, more especially, the new engine made by this firm, which embodies improvements and up-to date features.

The Battle Creek Steam Pump Company, Battle Creek, Mich., U. S. A.=Illustrated descriptive catalogue of the "Marsh" steam pump as manufactured for different uses, in pumping water, syrups and other thick liquids, milk, oil, naphtha, etc., with dimensions, capacities, and price-lists.

Fred. M. Locke, Victor, N. Y., U. S. A.=Catalogue of high-insulation line material, with cuts and descriptions of insulators and appliances.

Strange Forged Twist Drill Company, New Bedford, Mass., U. S. A.=Price-list of forged twist drills, drill-chucks, reamers, and other machinists' tools.

Charles P. Willard & Company, Chicago, Ill., U. S. A.=Catalogue with illustrated descriptions of steam yachts, steam launches, and yacht appliances, manufactured by this firm. Details of construction, size, and capacity are presented.

The Whitlock Coil Pipe Company, Elmwood, Conn., U. S. A.=(*a*) Catalogue and price list of the American feed-water heaters and purifiers, illustrative and descriptive. (*b*) Smaller catalogue, letter-envelope size, illustrating and describing the same articles as above. (*c*) Illustrated price-list iron, steel, brass, and copper pipe coils.

For additional catalogues, see page 32, under Improved Machinery.

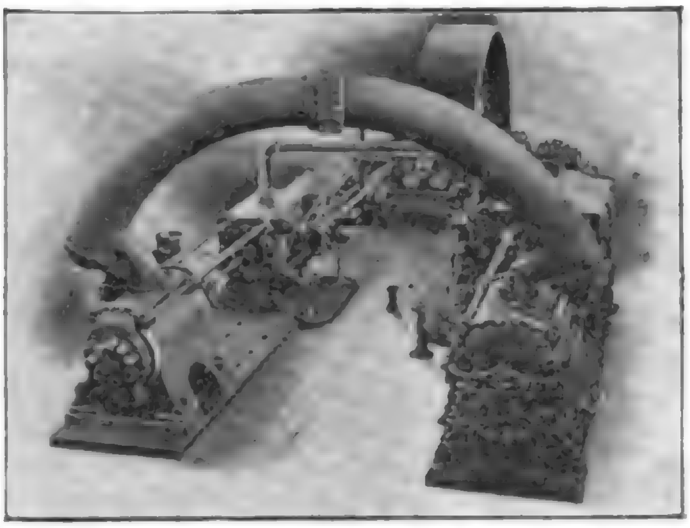
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Largest Compressor Engine in Canada.

THE compressor engine shown in the engraving, is the largest ever put in operation in Canada, and recently installed at the famous Le Roi mine, Rossland, B. C., was built by the Rand Drill Company, of 100 Broadway, New York City, in their Canadian shop at Sherbrooke, P. Q., It is a beautiful piece of mechanism, as seen standing on the shop floor. The steam engine is a cross compound condensing machine of the Corliss type. The high pressure cylinder is 22 inches in diameter by 48-inch stroke, taking steam through a pipe 6 inches in diameter. The low pressure cylinder on the opposite side of the machine is 40 inches in diameter by 48 inch stroke. Both cylinders are fitted with the Corliss liberating type valve, with vacuum dash pot, and with a sensitive governor operating on the release gear, to be operated automatically from six or eight revolutions to the maximum number of revolutions per minute. The main shaft is 14 inches in diameter by 13 feet long, weighing about 5,500 pounds, and fitted with cranks pressed on. The connecting rod forgings and piston rod forgings are well and carefully finished.



THE LARGEST COMPRESSOR ENGINE IN CANADA.

The air end of the machine is fitted tandem with the steam cylinders, and is also compound, the high pressure air cylinder being 22 inches in diameter by 48-inch stroke. The valve motion supplying these cylinders is Rand's most economical type, being in the form of mechanical valves. By this means the filling of the low pressure cylinder with air at atmospheric pressure is insured, which largely affects the efficiency of the machine; for, were the cylinder either not completely filled, or were the air hot and expended, in just such a ratio would the efficiency be decreased. The inlet valves of the low pressure or intake air cylinder are surrounded by a hood which is connected to a flue for the introduction of the cold air from out of doors. Between the high and low pressure cylinder is an intercooler of the latest type Through this intercooler the air passes over a system of water-circulating pipes and is cooled in the process. This giant compressor engine will be used for running all the pumps and hoists at the mine in addition to operating 40 drills.

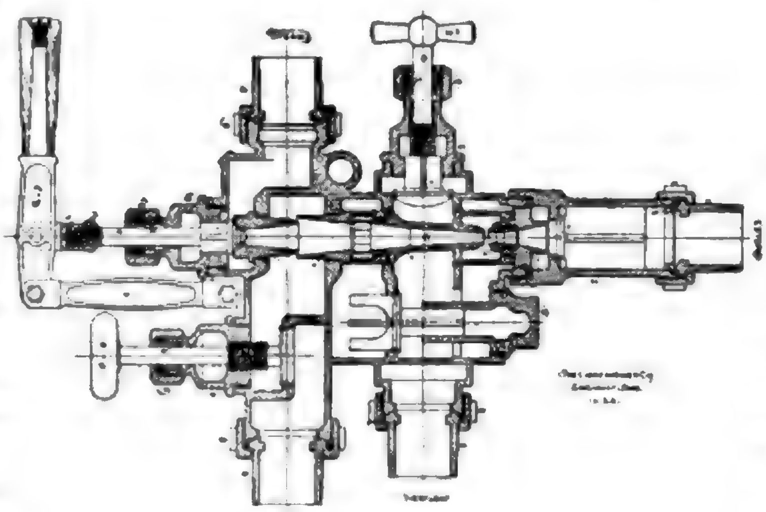
A Broad Decision In an Infringement Patent Suit.

A BILL in appeal having been filed in the circuit court of the United States for the eastern district of Pennsylvania, by the Ewart Manufacturing Company (whose general agents are the Link Belt Engineering Co., of Philadelphia) against James H. Mitchell, to enjoin the alleged infringement of the claims of letters patent No. 264,139, issued September 12,1882, to James H. Dodge for an improvement in Chain Cables, generally known as the "Dodge Chain," that court was of the opinion that Mitchell's device did so infringe, and decreed an injunction. The respondent appealed from this decree,and the case went before the court of appeals for review, and Judge Buffington decided in favor of the Dodge patent, using the following language: "In our judgment the device shown by Dodge's patent was novel in character, disclosed an invention of very decided merit, and was a substantial advance over mechanical constructions theretofore used in the art to which it appertained, and the claims of the patent should have such a construction as will

give the patentee the full benefit of the advance which he has contributed to the mechanical arts, and claimed." He states that the differences in the respondent's device are only apparent and superficial, and he affirms the opinion of the lower court that Mitchell's device is an infringement of Dodge's patent.

The Lunkenheimer Automatic Single-Tube Injector.

THIS is an automatic, single-tube machine of the fixed nozzle type. Should the machine stop forcing (from interruption of steam or water supply) the injector will restart without attention as soon as the supply is resumed. When the injector "breaks" from stoppage of water supply, the steam will not go down the suction pipe, thereby heating the water and rendering it too hot to work (or where supply is taken through a meter injuring the same), but will blow through the injector into the atmosphere, thereby creating a strong draft through the machine. When the water-supply is resumed it will come up to the injector, which will start at once to force it into the boiler without any attention from the operator. Many injectors are claimed to be automatic in action, but few are really so, and most of those which do approach an ideal performance of this feature soon wear out; the part which makes them automatic, *i. e.*, the check valve, closing the overflow chamber between water lifting and combining tubes, either cuts out or scales up. In the Lunkenheimer automatic injector this valve is so made that it will not cut-out and even though it should not be perfectly tight it will not materially impair the working of the machine. It is claimed to be the only durable automatic injector on the market. It has no delicate or complicated mechanism, the several parts are large and easy of access for examination and repairs without the use of special tools. Owing to its construction the injector will start promptly at all steam pressures from 30 lbs. up to 250 lbs., and higher on lifts not exceeding 18 feet. It is not necessary to prime it in starting, as the single movement of the lever is sufficient to admit steam and the water is promptly lifted to the injector, which will at once start work.



LUNKENHEIMER'S AUTOMATIC SINGLE-TUBE INJECTOR.

The injector is very prompt and positive in its action. Its capacity may be reduced fifty per cent. from the maximum, the operation being just as steady as when at maximum delivery. Its working range is claimed to be equal to that of any injector on the market. Much care and study have been devoted to its design, particularly in properly proportioning tubes and internal valves. In the claims for its durability and reliability due allowance has made for average practical conditions.

This injector, it is claimed, is the only one on the market combining with its other regular working qualities an adaptability to places wherein it is desirable to wash and test boilers. The workmanship and materials are of the best quality, and the injector is adapted to all kinds of service, whether locomotive, marine, or stationary, giving equal satisfaction in all kinds of service.

Forced Draft for Combustion of Culm.

THE Buffalo Forge Co. (corner of Broadway and Mortimer Streets, Buffalo, N. Y., U. S. A.) having several years ago installed one of their forced draft plants for the Williamsport Steam Company, Williamsport, Pa., now send us an extract from a letter received from the latter, very highly commending the plant, expressing great satisfaction with its operation, stating that "it has proved itself" to be "a great saver in fuel expenses," and promising to "speak well for the plant to any one making inquiries." There is no dispute of the fact that modern engineering tends more and more to artificial draft, and that the steam jet blower, though it demonstrates the value of a forced draft, is not generally held to be the ideal means for creating such a draft. Modern practice seems to have proved that in the combustion of culm the use of fans for forcing draft is preferable to the steam jet, and we believe this view is held by most consumers of culm, in sections where large accumulations of this fuel render it cheap and easily attainable, as in the eastern part of Pennsylvania and other coal mining re-

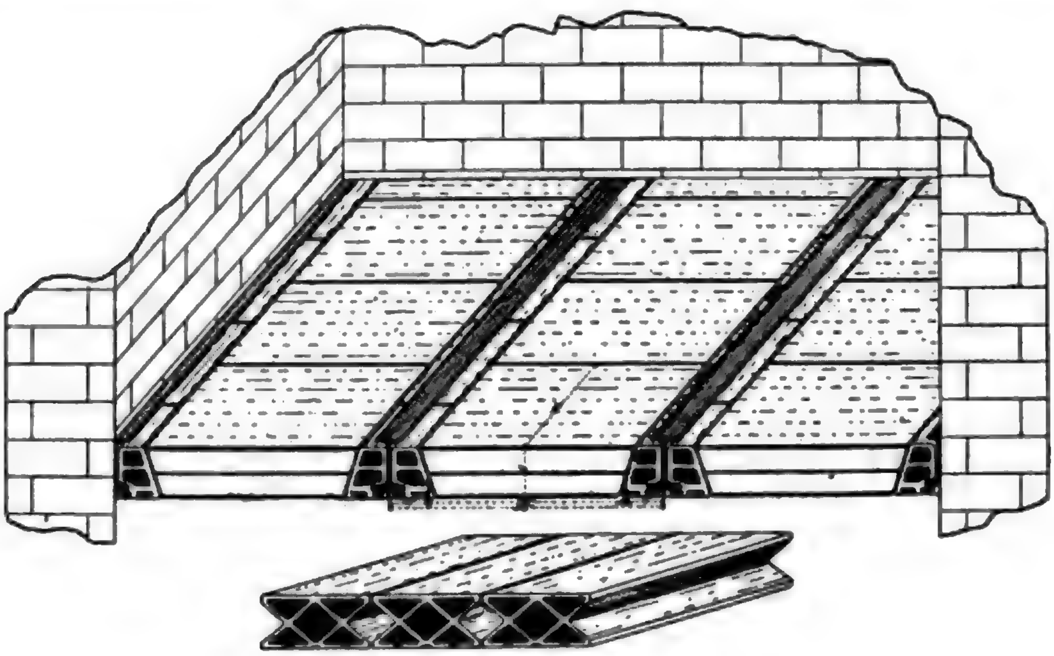
gions. The success of the forced draft plants installed by the Buffalo Forge Company justifies us in bringing them to the attention of those now using culm as fuel, or contemplating such use.

Eureka Hollow Tiles, for Light Floor Construction.

THE engraving illustrates the construction of a light floor made of the "Eureka" hollow patented tiles manufactured by Henry Maurer & Son, 420 East Twenty-third street, New York.

The design is that of an arch, composed of three tiles set between 5 in. or 6 in. deep beams, and consists of two abutments, or "skewbacks," which fit the beams, thoroughly protecting the lower flanges, and a centre or "key" brick. The tiles, being hollow longitudinally, adapt themselves readily to the tie-rods, without cutting. To insure a perfect and well-constructed arch of this design, it is absolutely necessary that the iron beams be spaced either 30 in. or 32 in. centres. Tiles made in *one* piece, owing to their length, are liable to frequent breakage, entailing the loss of an entire tile, whereas in this method, there being three distinct pieces, should either end-brick get broken, only 4 in. are lost.

An arch is much stronger than any single tile spanning the entire distance between beams. The "Eureka" adds the advantage that, as the entire depth of the beams is filled in, the cost of labor and material for concreting are wholly saved. In calculating for a design, especially for floors, no allowance should be made for the strength of the concrete, but the cement covering should be considered so much extra load on the system. It is the usual custom, in designing a fire-proof system, to consider that the concrete bears its share of the loads upon the girder, and in a great many cases the girder is designed on that assumption. If no fire occurs this is all right, but it is specifically against that element that the "Eureka" system furnishes a safeguard. If a severe fire occurs, the concrete loses its cohesive properties, both on account of the loss of its water hydration and the great internal strains caused by the expansion of one side under heat, and consequently becomes unable to resist stress anywhere near what it was originally able to bear, and in most cases would not even be self-supporting. Experiments have shown that sudden heat is extremely ruinous, much more so than heat gradually applied; and in an average fire a very high temperature is generated in an incredibly short time, and concrete subjected to its action would, very soon, be unable to bear any strain whatever. A fire of ordinary intensity is sufficient to ruin completely a very large covering of concrete, and water applied to hot cement is extremely ruinous.



EUREKA HOLLOW TILE.

The "Eureka" system is simplicity itself; as the tiles cannot work loose, no centring or cement is required, and the ease and rapidity of setting it (equal to two and one-half times that of any other construction of its kind) will recommend it to all seeking a light floor construction, cheap, while thoroughly fire-proof, and capable easily of sustaining a load of from 150 to 200 pounds per square foot. The manufacturers are placing this construction on the market, in full confidence that it will fully meet all demands and requirements for light fire proof flooring.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Sullivan Machinery Company, Chicago, Ill., U. S. A.=Catalogue No. 28, May 1, 1897. Illustrates and describes the "Sullivan" rock drills, and diamond drills, "Sullivan" channeling machines, and other mining and quarrying tools, appliances, and supplies, giving also tabulated dimensions, weights, specifications, and price lists.

Best Telephone Manufacturing Company, Baltimore, Md., (U. S. A.=(*a*) Elegantly-printed pamphlet, entitled "How the Best Telephones are Made: Told from Photographs." The half-tone illustrations accompanying the descriptive text are taken from parts of the company's factories, and the whole forms an interesting booklet. (*b*) Circular, illustrating and describing a telephone for the use of divers on the ocean's bottom, and entitled "Deep-Sea Talking."

The Stiles and Fladd Press Company, Watertown, N. Y., U. S. A.=Catalogue, remarkable for its extent, considering that this company shipped its first machine about May 1, 1896. The catalogue comprises an extensive line of drop-hammers, dies, and special machinery for metal-working, which tools are illustrated and described. Prices and dimensions are also presented.

Semi-Steel Company, King and Andrews Company, Chicago, Ill., proprietors Birmingham Iron Foundry, Derby, Conn., U. S. A. Licencees.=Pamphlet describing the properties of the so-called semi-steel, and presenting comparisons of its strength with best grades of cast-iron, chill roll iron, gun-carriage metal, car-wheel iron, heavy-machinery, stove-plate iron, and Bessemer iron. Testimonials from users.

The Cleveland Stone Company, Cleveland, Ohio, U. S. A.=Illustrated descriptive catalogue of grindstones for all purposes, and mounted grindstones for hand and power use; with specifications and price-lists.

The Vitrified Wheel Company, Westfield, Mass., U. S. A.=Illustrated and descriptive catalogue of "New Process" porous vitrified emery and corundum wheels.

The Goulds Manufacturing Company, Seneca Falls, N. Y., U. S. A.=(*a*) Catalogue illustrating and describing a line of power-driven water-supply and tank pumps, with tables of sizes, capacities, etc. (*b*) Similar catalogue of boiler-feed pumps. (*c*) Similar catalogue of paper-mill stuff and suction pumps.

Reading Crane and Hoist Works, Reading, Pa., U. S. A.=Catalogue and price-list (for 1897) of hand-power travelling cranes and jib cranes, portable chain hoists, overhead tramways, and general hoisting machinery.

The Egan Company, Cincinnati, Ohio, U. S. A.=Large illustrated poster catalogue of wood-working machinery, to be posted in prominent places for reference.

Munn & Co., New York.=(*a*) Catalogue of books recently published. (*b*) "Scientific American Hand book on Patents, Caveats, and Trade-marks. (*c*) Catalogue of papers contained in Scientific American Supplement. (*d*) Catalogue of scientific and technical books published, imported, and sold by this firm.

The Garvin Machine Co., New York.=Illustrated descriptive catalogue of the extensive line machine tools manufactured by this company.

Ross & Company, London.=(*a*) Pamphlet illustrating and describing the electric arc light for lantern projection, the Ross-Hepworth arc lamps, and new patent "Ecentrical" carbons. (*b*) Pamphlet illustrating and describing the photoscope and its uses. (*c*) Circular announcing prizes for a photoscope competition. (*d*) Circular illustrating and describing the "Ross New Model" binocular field glass. (*e*) Circular relating to the Ross-Zeiss Convertible Anastigmats. (*f*) Circular containing tables of contents of different catalogues published by this firm.

Standard Underground Cable Company, Pittsburg, New York, Chicago, and St. Louis, U. S. A.="Pocket Handbook," containing useful information, price-lists, telegraph code, relating to lead-covered cables, insulated wires, etc.

Baldwinsville Centrifugal Pump Works, Irvin Van Wie, proprietor, Syracuse, N. Y., U. S. A. =Catalogue H., illustrating and describing centrifugal and "Triplex" pumping machinery, pumps, gasoline engines, boilers, fittings, etc.

R. K. LeBlond, Cincinnati, Ohio, U. S. A.= Catalogue illustrating the "LeBlond" machine tools, and special machine-shop labor-saving appliances.

The Eynon-Evans Manufacturing Company, Philadelphia, Pa., U. S. A.= (*a*) Catalogue (third edition) illustrating and describing specialties manufactured by this firm in the lines of hydraulic machinery, bronze founding, etc. (*b*) Circular relating to Smurthwaites "Old Reliable" steam-trap. (*c*) Circular setting forth eight points of merit of the "Eynon-Korting Compound Injector.

The Jeffrey Manufacturing Company, Columbus, Ohio, U. S. A.=Catalogue of chain belting and steel cable elevating and conveying machinery.

Anglo-American Cycle Fittings Company, New York.=Catalogue illustrating and describing cycle material specialties—parts and fittings.

Charles H. Besley & Co., Chicago, Ill., U. S. A.—Catalogue illustrating and describing an extensive line of manufacturers' and machinists' hardware, fine tools, and supplies.

Wiley and Russell Manufacturing Co., Greenfield, Mass., U. S. A.=Catalogue of patent screw-cutting and other labor-saving machinery and tools.

For additional catalogues see page 676, under Books of the Month.

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SOUTH AFRICA AS A LAND OF OPPORTUNITIES.

By Robert Wallace.

THE area to which attention is directed is that great section of Southern Africa which lies to the south of an imaginary line drawn somewhere to the north of the eighteenth meridian of south latitude and corresponding for some distance with the course of the river Zambesi. In the extreme south we have Cape Colony; in the northwest, German West Africa; in the east, the British colony of Natal, the two Boer republics, (the Orange Free State and the Transvaal), and the southern extremity of the Portuguese possessions; and, in the center and to the north, Bechuanaland and southern Rhodesia, the latter of which was formerly designated Matabeleland and Mashonaland. The great backbone of this part of the African continent is the Drakens Bergen range of mountains, running up to heights of more than ten thousand feet in some placcs, and not occupying a central position, but lying at a distance of from one hundred to one hundred and fifty miles inland from the east coast. A continuation of the range forms the most northerly and the most elevated of three mountain ranges which traverse the southern portion of Cape Colony in lines running east and west. Being at different ele vations with the general land surface to the north at a higher level in each case, they have been aptly likened to a stair of three steps, by which the great and somewhat irregular central plateau forming the greater portion of the area muy be approached from the south.

The general elevation above the sea may be roughly stated as varying from four thousand to six thousand feet. Johannesburg stands on one of the highest sections of this vast plain, and the surface falls

away gradually and irregularly, as may be seen by following on a map the direction of the rivers towards the west, where it is bounded by the west coast range of mountains in the German territory, and to the north, where it drains into the river Zambezi. The monotony of view is broken in places by "kopjies," or low, flat-topped hills formed of the remnants of rock strata which have escaped the weathering influences that led to the denudation and lowering of the surface surrounding them, or of basaltic rocks which have been obtruded in past ages by volcanic action. The geological and land surface appearances of South Africa are unique, and display features characteristic of that country. While volcanic action in remote periods has been wide-spread, it has been more local than general, and immense areas exist where the strata remain undisturbed, and consequently horizontal in position. This fact is brought constantly to the notice of the traveller by the recurrence of the flat-topped hills alluded to.

Although the South African flora is one of the richest in numbers and in the exquisite beauty of the inflorescences of individual specimens, the general appearance presented is that of barrenness and a lack of brightness in the bulk of the foliage. With a few notable exceptions, there is a general want of covering and protection or shelter for the land surface itself, as well as for the animals that graze upon it. Along the south and east coasts more particularly, where the mountains assist in attracting moisture, there is abundance of rain, and vegetation generally is luxuriant, the latter becoming more and more tropical in character as one proceeds in a northerly direction. Heavy timber exists in but small areas in Cape Colony and Natal, but in some parts of Rhodesia what is known as "heavy-bush" covers a considerable extent of country. In these northern parts the growth generally is more luxuriant, the soil being deeper, and the temperature higher, than at the same meridian of longitude to the south.

The mean annual temperature of the central and north central area of South Africa ranges between 65° and 70° F. In the north-east it is a few degrees higher, while throughout the greater part of the Orange Free State, Cape Colony, and German South-West Africa it is a few degrees lower. Rainfall does not closely follow temperature. The area to the east of the Drakens Bergen mountains is copiously watered by a fall of more than fifty inches annually. The Transvaal and Free State come within the eighteen- to thirty-inch division, and two-thirds of the area of Cape Colony receives, like a narrow belt traversing the center of the country from north to south, the rather scanty supply of between six and eighteen inches. The north west of Cape Colony and nearly the whole of the German area,

together with the western section of Bechuanaland (a portion of the great Kalahari desert), have the altogether insufficient mean annual rainfall of less than six inches. Such variations of temperature and rainfall produce sharp lines of demarcation in the conditions of different parts of the country, in the appearance of the natural herbage, and in the stock and crops which may be advantageously reared.

Large areas in the districts of light rainfall cannot be profitably cropped without the aid of irrigation, but the mountain ranges already mentioned as a prominent feature of Cape Colony readily lend themselves to interesting engineering schemes for storing rain-water against the dry season by closing the outlets of mountain gorges. To supply the requirements of live stock, surface-water is collected and preserved in shallow dams formed by the erection of low earth embankments roughly faced with rubble thrown on to form a sort of irregular pavement; but, as these stagnant pools become filthy with the droppings of animals which cannot be prevented from walking in them, and are also prolific centers for the distribution of internal worm parasites, South African farmers have been strongly urged to sink wells, in order to tap a very general and, for live-stock requirements, an excellent underground water-supply, to be found almost everywhere. Contrary to the usual experience in the Australian colonies, the water generally has to be pumped,—the most convenient power being one of the new forms of rigid, annular-sailed air-motors.

In the dry regions the rain falls very irregularly, and usually very suddenly, in deluges of thunder showers, producing for short periods muddy rivers of great depth and formidable strength in the hollows by which it escapes to a lower level. The only herbage which is capable of withstanding the long periods of drought are the so-called Karoo-bushes, with little succulent cylindrical leaves and woody stems and branches. These do not form a close sward, as grass does, to protect the surface soil particles from washing away in the flood, and the consequence is that from the dry districts South African rivers in flood are colored like pea soup. This action, continued through long terms of years, accounts to a large extent for the lower surface-level of these particular regions, and the thin covering of soil which remains, as compared with that of the more northern and eastern areas, where Karoo bush, after for some distance mixing with tufts of grass, ultimately gives place to a grassy covering, though not of the closest description, or to thorn-bush. Grass also grows luxuriantly near the coast, where rainfall is abundant; but there, as in most regions of South Africa, on the tops of mountains and north of the Karoo-bush areas, grass assumes as it matures, and as the dry season

advances, a hard form, described as "sour," on which animals do not thrive well. The herbage is not acid to the taste, but unpalatable on account of its mechanical condition.

With the exception of the regions of heavy rainfall on the east and south coasts, all parts of the country are periodically subjected to long periods of drought, which try the endurance of both live stock and the natural vegetation. The plants are found to possess various means of protection against excessively dry weather in the form of narrow, succulent leaves, which expose but a small area for the transpiration of moisture, bulbous roots, in which food is stored during seasons of plenty to be ready to sustain life and mature seed in times of prolonged drought, or, it may be, deep roots, which enable them to find a supply of moisture from the great underground reservoir. As a safeguard against vital injury from the browsing of animals, the trees, on the leaves of which small stock feed, are protected by sharp spines or thorns. The so-called "mimosa," *Acacia horrida* (Willd), is the most typical, and by far the most widely-distributed, tree in South Africa, being able to maintain its existence even in arid parts, along the courses of the channels which carry off flood waters. What its defences deprive animals of in the form of leaves, it makes good by shedding a plentiful yield of seed, which form excellent food, and are greedily picked up by all classes of herbivorous creatures.

Where irrigation-water can be had, there are few soils so deficient in lime that lucerne (alfalfa) will not grow on them to perfection, and, while yielding a large amount of green food, will continue to make the soil more fertile than before. This best of all forage crops has begun to play an important part in the development of South African agriculture.

The coast is furnished with two excellent harbors, one at Cape Town entirely under British domination, and the other at Delagoa bay, at the southern extremity of the Portuguese territory, over which Britain has acquired certain rights in virtue of a commercial treaty recently entered into with Portugal. Other inferior ports are made places of call, except when the weather is very stormy, by the ocean-going steamers to England,—*viz.*, Port Elizabeth, East London, and Durban.

Much remains to be done to develop a sufficient net-work of railways for local convenience, but the country is already well provided by trunk lines. These systems connect Cape Colony with the regions lying to the north. The western system, starting at Cape Town, and the Midland system, starting at Port Elizabeth (the two joining at De Aar), are represented further north by a single line which passes the great diamond field of Kimberley, and Mafeking, the starting-

point of Dr. Jameson's ill-starred expedition into the Transvaal, and terminates in Rhodesia. The last section of the line to reach Buluwayo, it is expected, will be open in October of this year, and not many months thereafter need elapse before Salisbury is connected with Cape Town. The eastern railway system from Cape Colony, starting at East London, extends to Aliwal North, but it also unites with the western and midland systems within the colony, and one line connects them all, by way of Bloemfontein (the capital of the Orange Free State), with Johannesburg, the gold-mining capital of South Africa, and with Pretoria, the political capital of the Transvaal.* Pretoria is also connected by rail with Delagoa bay, but the management is under Hollander influence, and is not conducted with a single eye to the development of the country. Johannesburg is also much nearer by rail to Durban than to Cape Town, but there are the disadvantages of a very steep gradient and zig-zagging of the permanent way in getting up the eastern slope of the coast range of mountains, and, moreover, passengers from Europe have to encounter eight hundred miles of sea voyage from Cape Town to Durban. The Mashona capital (Salisbury) can be reached by way of Beira and the Pungwe river, and thereafter by rail and coach. Although the journey is less than three hundred miles, the way passes through the low-lying malarial belt of country along the sea-board, in which east African fever prevails, and Beira, which is no great seaport, belongs to the Portuguese, and is still further from the main current of ocean traffic than any of the other landing-places mentioned. It is true that the railway journey from Cape Town to Rhodesia is long,—more than one thousand two hundred miles to Buluwayo, and to Salisbury about two hundred and fifty miles further,—but it lies through British possessions healthy for man and beast, and capable of such development as will guarantee the financial success of the railway enterprise.

Before railways were laid down, the carrying-trade of the country was done almost exclusively by ox-wagons drawn by spans of sixteen oxen, mostly of the Africander breed—the descendants of the original native cattle of that country crossed by imported Portuguese cattle before Great Britain assumed possession of the Cape Colony. The through traffic was done by so-called "transport-riders," who, owing to high railway rates, are in some districts not yet entirely driven off the field by railway competition. Farm work and local traffic are, in most districts, entirely dependent upon ox-power. In

* In Cape Colony in 1896 the total length of open railways was 2,253 miles—a figure which has been stationary for about four years. The traffic, meanwhile, has made most satisfactory progress. In 1893 the train-miles run were, in round numbers, nearly 7,000,000; the passengers carried, 5,335,000; the goods traffic, 863,000 tons. In 1896 the miles run almost touched 10,000,000; passengers, 8,000,000; goods traffic, 1,380,000 tons.

the arid Karoo regions small donkeys may be seen taking the place of oxen in road work, and in some parts of Cape Colony mules, and more rarely horses, work in the plough.

The terrible plague of rinderpest, the most deadly of all bovine diseases, which has been and still is making dreadful havoc among the cattle of South Africa, is a calamity the far-reaching importance of which it is difficult to realize. It is not only the meat- and milk-supply of the country that is at stake, but the bone and sinew of its working-power. The disease is a blood disorder, in which a micro-organism appears in the circulating blood. The temperature rises to 106° and 107° F. at an early stage of its development. Every organ of the body becomes deranged, and the animal usually dies in about a week, after a period of extreme suffering and prostration. On its first appearance in a country its ravages are most deadly. Only one per cent. of the animals attacked in South Africa have recovered. The disease entered the country from the north, having found its way probably from Egypt, where in 1881, we believe, a cattle murrain devastated the herds, and bred, through the pollution of the water-supply, a deadly plague among the people. Joseph Thomson, the African traveller, describes it, though imperfectly, in his book on Masailand, and other explorers and hunters have mentioned its ravages upon buffaloes, wild pigs, and the numerous species of antelope.

It is a well-known fact that cattle, such as bullocks of the Africander breed, are superior to horses and mules for the heaviest part of the traction work under South African conditions. They are able to exist on scanty and inferior fare, and to withstand the effects of rough roads and the great heat of the sun by day alternating with low ranges of temperature at night, with which the equine species could not successfully cope. Another serious drawback to the substitution of mules and horses for oxen is the liability, particularly in the low-lying districts of the country, to periodical outbreaks of horse sickness, causing the sudden death of thousands of valuable animals. Horse-sickness is a febrile disease produced by the growth of a micro-organism in the blood, and is probably contracted during the inhalation of fogs which rise from the surface of the ground at night, as animals housed and properly protected do not suffer from it. After the death of so many bullocks, many mules will be required in South Africa, and America will no doubt be called upon to contribute a large proportion of this supply.

It is impossible to foretell the far-reaching influences for good and evil which the loss of cattle by rinderpest will have upon the future of South Africa. It will certainly ruin many struggling agriculturists, and produce great privations and suffering among the

Kaffir population. It has been credited with driving the Matabele and Bechuanas into rebellion. It will lead to the extension of crop cultivation among natives who formerly depended largely upon meat and milk for their subsistence. During the recent unsettled times, in which native labor was liable to be driven away from the great mining centers, it has led to the maintenance of a supply of labor which, but for the hardships due to the rinderpest, would not have been forthcoming. This has led to reduction of wages at the mines, which, contrary to the general economic principle, has been a boon to the community at large. It has transferred a number of doubtful mining ventures that maintained a precarious existence between success and failure into the class of paying properties. It has relieved to some extent the pressure of high wages upon the agricultural industry,—a condition which was induced by the excessive wages paid at the large mining centers. It has been the practice for young men from the native population to repair to the Kimberley, Johannesburg, and other mines, where they have earned in a few years as much money as was necessary for each to purchase two or three wives and as many cattle as would enable them to live in ease and idleness for the remainder of their natural existence. The reduced wages will necessitate a longer period of work before this tawny lord of creation will be in a position to settle down to a life of indolence and grow fat upon the produce of his wives' labor and of his milch cows. The extension of the period of work will be wholesome to himself and a benefit to the country, and it may also prove a retarding influence to the too rapid increase of population. The most recent phase of the labor question, owing to the prolonged state of general unrest and distrust, is the scarcity of Kaffir labor at the Johannesburg mines. A greater feeling of security, and not the raising of wages, is the necessary remedy in this case. In the Kimberley Compounds, where it is necessary to prevent direct communication between the mine workers and the people who are at liberty, with the object of stopping the wholesale stealing of diamonds, the life of the native workman is of the most pleasant and agreeable kind, as may be seen from the healthy and happy appearance which all and sundry present. The period of work is not too long, and the ample hours of leisure are spent in basking in the sun, gossiping, and other relaxations.

The great mass of the population of South Africa belongs to the Bantu race of dark-skinned negroids, divided into many distinct tribal groups, which, until British influences intervened, carried on incessant wars with one another. Prominent among these may be mentioned the Zulus, Makalakas, Basutos, Pondos, Bechuanas, Damaras, Mashonas, and Matabeles. It is physically a well-developed race, and its

mental capabilities are superior to those of the negro in the tropical regions lying to the north. The prominent representatives have been described as "fine, powerful, able-bodied men, reserved and self-possessed in manners, but courteous and polite." It cannot be denied, on the other hand, that many of the most prominent chiefs have been monsters of cruelty, and have ruled their people with a rod of iron, or that savage excesses of the most wicked kind were often exercised on the unfortunate white victims who fell into the hands of the rebels in the late Matabele war. Contact with the white man, though it has not been uniformly advantageous to the race, as will subsequently transpire, has developed a better and more Christian spirit in this respect. It appears, on the good authority of the British resident in Basutoland,—perhaps the most advanced and prosperous of all the native communities under British control,—that the more enlightened of the people were genuinely horrified at these cruelties.

One of the most conspicuous advantages which Great Britain has gained in successfully "picking the eyes" of the African continent by selecting the richest and most healthy areas for the development of an energetic population is the immense reserve added to her fighting power. She has become the mistress of a race of warriors, capable of rivalling the world-wide fame of the hill tribes of Northern India in their love of warlike adventure and their skill in modern warfare.

In Cape Colony there were, at the last census, taken in 1891, more than fifty thousand Hottentots,—a race much inferior in intellect and physique to the Bantus; and a few specimens yet remain in the semi-desert regions of a still lower and probably earlier race,—the Bushmen,—who are supposed to have left their marks in the shape of unique drawings of animals on the polished surfaces of basaltic rocks and in caves in different parts of the country. Neither of these races, or yet the fourteen thousand Malays who have settled in Cape Colony, call for much consideration in discussing the future prospects of South Africa in regard to population.

The future of the Bantu family is in itself a large enough question for serious consideration. Under native rule the warlike proclivities of the men, whose main object in life was bloodshed, while the women, who were little better than slaves, did the manual labor of the community, restricted the tendency to the inconvenient increase of population; but, with the cessation of wars under the benign influence of civilized government, the population has started on an era of expansion which will probably keep pace with the development of the agricultural resources of the country, if it does not over-reach it.

The wants of the native in his natural state are not numerous. Of the grain crops the "mealie" or maize is the most widely grown and

most important. The next most important grain crop is Kaffir-corn, or great millet, *Sorghum vulgare*, the juár of India. This, like maize, is a dry-land crop, but it can be also cultivated under irrigation. Wheat grows well in some parts, but in coast districts it becomes increasingly liable to suffer from rust or mildew. The high rate of labor and other local difficulties will prevent South Africa, for a long time at all events, from becoming a grain-exporting country. There is great scope for the expansion of grain-growing, but, with an ever-increasing population,—white and black,— it is more likely to be a grain-importing and -consuming, than a grain-exporting, country.

In spite of the unsettled state of things in Johannesburg and the native rebellion in Rhodesia, South Africa was in 1896 the most popular center for emigration. People flocked to it from Australia, Europe, and America, in a way that cannot well be explained.

But conditions are not ripe for the reception of many of the classes which go to form old communities. People who merely drive the pen and are not fit for manual work are not wanted at present. Mining enterprises must take the lead in the development of the country, and consequently engineers, surveyors, and mining managers of skill and ability will be required to occupy positions of trust. Men wanting in individuality, and whose qualifications are only second-rate, would do well to remain at home. They are more easily recognized and even less in demand in a new than in an old country. No energetic settler who is an expert in a handicraft, and who is willing to make a living at any kind of employment that presents itself, until he becomes familiar with his surroundings, need despair of ultimate success in his own sphere of work.

One of the curses of the longer-settled parts of South Africa has been the belief that a white man ought to be superior to manual labor in a black man's country, but these ideas do not follow in the train of success in pioneer enterprises, and they have produced in Cape Colony a class of people known as "poor whites," who live a wretched existence, morally and physically, and are rapidly becoming a serious burden and anxiety to the State.

Energetic agriculturists and experts in gardening and fruit growing, with a few thousand dollars of capital, will find full scope for their abilities, and excellent markets at the large mining centers.

South Africa will one day be a great empire ; but, although the skeleton has been outlined, it will take considerable time before the flesh can be built up. Progress will have many difficulties to contend with, climatic,—alike affecting crops and live stock,—racial, and political. The blacks will not be difficult to govern when they fully realize the justice and the firmness of British authority. It

will never do to treat natives too leniently when correction is necessary. They have been so accustomed for generations to the severity of their chiefs that they even seem to like it! Leniency to a black man is invariably mistaken for weakness, and advantage is taken accordingly. One serious feature in the future of the South African native is hidden in mystery, which only time can dispel,—*viz.*, the result of the influences of the evils which usually accompany European civilization when it is first meted out to inferior races. For example, the curse of strong spirituous liquors, to which natives too easily fall victims, and the introduction of syphilis, which has played such havoc among the native population in India, and has got so thoroughly rooted in Africa, that in a well-governed State like Basutoland, of which reliable statistics are available, it appears at the top of the list as the most prevalent of all the diseases under medical treatment. These are deplorable circumstances, as they undermine at one and the same time the physical and moral well-being of the communities affected.

Although much has been heard of the disagreements between Boers and Britons, little fear need be had of permanent or serious difficulties arising between them. The Boers form one of the most excellent sections of her majesty's subjects,—solid, sober, substantial, frugal, and sagacious, though some may be dogged and obstinate in their isolation and from want of education in the world and its way.

In bigotry and narrow-mindedness, and in other well marked characteristics, many of the less progressive of the class strongly resemble the old Scottish Presbyterians of a hundred years ago, and, being of the same race, there is no reason why time and education should not do for the South African Boer community what they have done for Scotchmen. The root of the difficulty does not lie so much between the Boers and British as in the the introduction between them of an alien Hollander-Dutch element as educated and accomplished mischief-makers, and the acknowledged corruption of the government, due largely to their and the German Jew ascendency which prevails in the secret council of the so-called republic of the Transvaal. It may be accepted with confidence that Britain means to retain, despite all opposition, the paramount power in South Africa, and to this end she has already strengthened the permanent garrison of Cape Colony. It is not believed that a Boer war is likely to occur, and such an event would be deplored by all who have a personal knowledge of the Boers and their ways; but, if such a calamity were forced upon us, we believe there would be little bloodshed, because so overwhelming a British force would be sent as would make the result a foregone conclusion. The hopeless nature of the fight would be-

come apparent to the most ignorant of them, before they had to pay a penalty similar to that from which Greece is now suffering for her stubborn indifference to the counsels of wisdom.

It is impossible to closely estimate the shrinkage of capital and the injury done to trade and to the development of the country by the extremely unsatisfactory political situation in the Transvaal. But, while admitting the monetary loss to individuals to be very great, amounting to tens of millions of pounds sterling, it is encouraging to see, from the official returns of the out-put of gold during 1896 at the Whitwatersrand (the Johannesburg gold field), that it was a few ounces more than the out-put for the previous year. In 1896 it amounted to 2,281,544 ounces, and in 1895 to 2,277,635 ounces, which figures, at the common estimate of £4 per ounce, give the handsome sum of more than £9,000,000 sterling in each of the two last years. Another hopeful feature is the increase in the import trade, as is shown in a return recently made by the French consul at Pretoria, who states that "in 1896 imports into the Transvaal amounted to 352,000,000 francs,—an increase of 107,000,000 on those of the previous year."

The struggle which European powers are making to secure a greater foothold in Africa is due in a great measure to the desire to secure the new market for home manufactures which will open up as the country becomes civilized and more densely populated.

In connection with Professor Wallace's careful and intelligent review, the following, from a trusted correspondent of the London Daily *Chronicle*, published May 28 last, will be read with interest.—Editor.

I have within the last few days seen many of the leading authorities on the Rand, and I found that, while for once they were absolutely unanimous about the reforms that are required to place the gold industry in a healthy state, there exists the widest possible diversity of opinion as to the amount of relief to be expected from the government. A very small class of Anglo-Boer tell you that things are sure to come right, and that the rules of this rustic republic must save the Rand in order to save themselves. I must confess that, with the exception of one or two well-known personages, you require the lamp of Diogenes to discover these hopefuls. The great majority of the Rand leaders have lost faith in Rand promises. In one respect there is entire unity of opinion,—that, whatever the Transvaal government does, it will be guided by its own pecuniary interest, and not by a desire to benefit the mines or the miners.

The representatives of English, German, French, and American syndicates and companies tell you that they would have no anxiety, if it were merely a struggle between the revenue of the State and the profits of the mines, because it might ultimately dawn on the dullest government that in the long run a liberal policy would pay best. But in the present case there comes between the government and the public a knot of Dutch and German speculators, who are making enormous fortunes from

monopolies that squeeze the life out of the gold industry, and linked with these are members of the executive and some of their relatives and friends. One member of the government is known to be realizing a princely revenue out of the dynamite contract; and you can understand how eloquently he is likely to plead for its abolition! Evidence has been laid before the commission of inquiry that dynamite with free trade can be sold for half what it costs to-day; that the industry is paying over £400,000 a year for its explosives, more than a fair price; and that of this sum the government gets only £50,000, while seven times as much goes to enrich the lucky German manufacturers, Dutch contractors, certain "unknown persons in Pretoria" (who are really well known), to whom 22,500 shares were allotted, and Mr. Lippert, who got 25,000 shares. The reader will readily conceive how these individuals will combine to press on President Kruger the equity of cutting down their profits by seventy five to one hundred per cent. A representative mining director said to me: "The dynamite monopoly is not the most crushing of our grievances; but it is the most iniquitous—it means nothing but plunder"; while the manager of a large group of mines, himself rather friendly to the Boer government, declared that at least one-third of the present charge for explosives must come off. This gentleman remarked that there had been some improvement of late, for in several recent instances the administration had declined to grant monopolies. A few years ago every concession was of this character, and there could be no doubt that officials were bribed to secure these privileges. This state of things is a bar to reform. A partner in one of the largest concerns in Johannesburg remarked: "We are asking the government to annul the dynamite contract, and to expropriate the Netherlands Railway. But the contractors and railway directors will fight for their rights. They are hand in hand with State officials, and who knows what exposures they may threaten if they are cornered? I will believe in these sweeping reforms when I see them; and paltry reductions will do us no good."

Of all the burdens on the Rand the railway charges are the most oppressive. The lines belong to the Netherlands South African Railway Company, which is always indicated in print as the Z. A. S. M., these beiug the initials of the Zuid Afrikaansche Spoorweg Maatschappij. This precious organization has made a world's record with some of its rates. It charges from Vereeniging (the first station in the Transvaal) 7.7d. per ton per mile for heavy goods—coal, machinery, timber, etc.—the Cape government and Free State railway rates being 1 1-3d. for the same goods, the Natal rate nearly 2d., and the Portuguese (from Delagoa bay) 2½d. A merchant sent an air-compressor from East London to Johannesburg, and was charged over the Cape lines 9s 4½d per mile, over the Netherlands section £1 16s 5½d per mile—nearly four times as much. The machine cost in England £1,269, and, when it reached Johannesburg, £2,018 17s. Bringing it over had increased the price over fifty per cent. But this is moderation itself compared with some of the freaks of the Z. A. S. M. Some rails were bought in England for £97 5s 8d,—delivered free on board,—whereas the railway charges alone came to £158 1s 2d, and, when these rails reached the Rand, they had cost £296 8s 2d,—an increase of 204¼ per cent. A quantity of retort carbon, imported from home, was delivered free on board for £20, and, when it arrived at Johannesburg, its price had run up to £132 6s 4d, or 561½ per cent. on the original value. A wag remarked that, in the deplorable event of a war between the Transvaal and Great Britain, if the republic should organize the officials of the Netherlands Railway into a cavalry corps, there would be poor chance for the Britisher, because nothing could withstand their charges. It is perfectly certain that the gold-mining industry cannot stand them. Almost everything the mining engineer uses, or the working miner eats, drinks, or wears, is made at least fifty to one hundred per cent. dearer by the railway monopoly alone. As a pretty illustration, by no means an extravagant one, take the following actual instance of the working of these transit

charges, in the case of timber,—an article of prime necessity in mining. It must be studied in detail in order to realize the full beauty of the transaction. A cargo of prime quality pitch-pine was sent by sailing ship from America to Johannesburg, *via* Delagoa bay, and this is how they did it:

Cost in the States	£2,379	7	1
Insurance and commission	242	19	9
General average bond	105	9	2
Port dues	66	16	8
Freight to Delagoa bay	3,012	10	0
Landing, forwarding, etc	1,503	15	0
Duty, etc	90	3	0
Cost at Delagoa bay	£7,401	5	8

From Delagoa bay to the Rand is 396 miles, and the carriage of the timber for this paltry distance just doubled the cost of it. Thus:

From Delagoa bay to Transvaal frontier, 58 miles	£ 844	2	6
Frontier to Johannesburg, 338 miles	6,517	6	0
Transvaal duty	42	16	0
Exchange and interest	52	9	0
Total	£ 7,456	13	6
Add cost at Delagoa bay	7,401	5	8
Total at Johannesburg	£14,857	19	2

I have before me a series of actual accounts showing that the original outlay for Oregon pine, Baltic deals, sheet lead, galvanized iron, steel plates, cement, tubes, lard oil, candles, bolts, nails, and mining machinery had been increased by carriage to the Rand from 53 to 792 per cent., and of this prodigious excess of cost the railway charges were responsible for a proportion ranging from 20 to 50 per cent. It costs, in every instance, about twice as much to bring goods by rail four hundred miles as to carry them by sea six or seven thousand miles. But why complain? The Netherlands Company, with a capital of £1,166,000, make a profit every year of £1,330,000, of which the government is entitled to about £700,000, leaving a comfortable return for the shareholder such as in these days few railways earn. Verily since the days of Canning "the fault of the Dutch" has not been taking too little and giving too much. In this case there is an obvious remedy. The government of the republic is entitled to buy out the Z. A. S. M., and by doing so at once it would soon be a large gainer. A reduction of rates would bring about an enormous increase of traffic, which would, without any question, produce an equal return to that now raised, while bettering the revenue of the State in every other direction.

This matter of railway rates, as affecting the cost of living and the chances of obtaining employment, is a serious one for workingmen who may be tempted by the high wages prevailing on the Rand. There are men here who are making £1 a day as miners, while a smaller number earn from 12s to 15s; but expenses are so high that married men with a wife and two or three children will find it hard to live in comfort. A statement submitted to the commissioner by a working miner showed that it costs four times as much, on an average, to live at Johannesburg as it does in England—the one being the cheapest and the other the dearest place in the civilized world. Speaking generally, milk is six times, butter three times, meat and bread double, groceries seven times, and rent six or seven times what they are at home. Single men can save money, but they must reckon the cost out and home again, which

cannot easily be less than £50, allowing for loss of time, and may be more. A working witness said that, if he had foreseen all this, he would not have got married and had five children to support. "Well," said the commissioner, "we all make these mistakes." My advice to the married miner in England is to hesitate about bringing his family to the Transvaal until these monopolies and railway rates have been reformed. It is a pitiless land for the unemployed, as I have seen in several cases; and it is to be remembered that there is practically only one industry. Of course the chances of employment would be enormously increased, if the economic conditions were ameliorated. In fact, there will be a brilliant future for gold and coal mining in the Transvaal, when honesty and a little common sense have taken possession of its rulers. Mr. Laurie Hamilton, speaking for the Barnato group of mines, states that they have six companies running with 400 stamps, seven idle with 650 stamps; but with better economic conditions they could easily have, within twelve months, 1,840 stamps at work, and a further addition later of 1,350 stamps. By the year 1900 this single group of mines might fairly expect to have 3,190 stamps running, and by the same time the various other groups, several of which are now closing down, reducing wages, and dismissing hands, could, and probably would, have 9,000 stamps at work. The economies which the United Rand are now pressing on the government would reduce the cost of working by 6s per ton, and restore dividends on millions of money, at present sunk uselessly. Will these economies be made? The only chance seems to be that the imminent, and, it is to be hoped, large loss of revenue will teach the Boer rulers wisdom. Only one must never forget Oxenstiern's lesson to his son: "You have no idea with how little wisdom the world is governed;" and the Swedish chancellor had not heard of the Transvaal.

DIFFICULTIES OF TRANSPORTATION IN THE TROPICS.

By C. P. Yeatman.

YEAR by year the manufacturing ability of the great industrial nations is outgrowing the demand which exists within their own territory; in the United States, as in England and Germany, the manufacturer is looking abroad for a market for what he cannot sell at home. Each decade finds the capitalist more at a loss as to how to get a good interest on his money.

To both of these the subject of methods of transportation in use in South American countries is of interest. To the manufacturer, because the weight and size of his packages, and the manner of packing, must conform to usage, or he cannot hold the trade; to the capitalist, because the fact that freight pays, apparently, a very high tariff in the tropics gives hope of a better return for his investments than he can expect at home.

Let us take, for example, the condition of tariff existing in Colombia, the nearest South American neighbor to the United States. The lines of traffic resemble the arteries of the human system, as they begin at the few sea-ports of the country and rapidly branch out in diverging lines for the interior. Just as the small arteries divide among themselves the total amount of blood carried by the principal artery, so the different roads leading from the sea-ports to the interior divide and sub-divide the traffic, until what at first was only a small amount becomes infinitesimal in quantity.

Leaving out of the discussion the Panama Railroad, as it has nothing to do with the interior of the country, the leading entry port is the city of Barranquilla, with a yearly import of thirty-four thousand tons, and exports of twenty-three thousand,—a total of fifty-seven thousand tons per annum. As the navigation of the mouth of the Magdalena river, on which Barranquilla is situated, is not practicable, nearly all the traffic is carried to and from the sea-coast by a three-foot-six-inch-gage railway, eighteen miles long, having nothing remarkable about it except its ocean pier, which is of steel and four thousand feet long, with twenty-six feet of water at its head, being surpassed in length by only two piers in the world. From Barranquilla the traffic goes up the Magdalena river on steamers carrying from one hundred and fifty to three hundred tons each. So far the transportation of packages of ordinary size and weight offers no diffi-

culty, but, when the freight leaves the river, trouble and expense begin ; for there are but three short railroads leaving the eight hundred miles of navigable river, and nearly every package which enters the interior of the country must, in some part of its journey, go on muleback, if it is small enough, or find some special mode of conveyance, if too bulky for a mule, or of more than one hundred and twenty-five pounds' weight. Let a single package pass the mule limit, and the cost of its mule-road travel will go up with a startling bound.

There are professional pack-carriers on some roads, who make a specialty of carrying burdens which the sturdy and much enduring mule cannot stagger under. On some of the roads you will see at times what appears to be a live box, staggering slowly and painfully down the mountain-side ahead of you ; as you draw nearer, you may hear the box grunt, very much as an old pack-mule does at each downward step on a steep road. There is something uncanny about the whole proceeding, if it is your first experience, and you happen suddenly to overtake the box, going down hill, for the moving, swaying, and grunting mass has no visible means of support, and no apparent excuse for behaving in such a manner. Perhaps you may read on its back, "Mason and Hamlin Organ Company," or some similar legend, but that is no help in solving the perambulating mystery, for whoever heard of a boxed up organ wandering alone down a steep mountain path, and grunting as it reeled along? Very likely the road is too narrow for your mule to pass your fellow-traveller ; so you are obliged to follow in its wake. But at last you are able to pass ahead, and you find that the organ is in no way to blame for moving, for it has a man under it. Short and stumpy he may be, but the muscle on him reminds you of the pictures of old Atlas holding the world on his brawny shoulders. In one hand he carries a long, stout cane, with which he steadies himself on the slippery clay, and, when he wishes to rest, he backs up to the bank on the side of the road, settles the lower end of his load against the higher ground, and props up the upper end with his stick ; then he is free to slip the plaited maguey fibre bands off his shoulders and forehead, and step out from under his burden.

Up the next hill perhaps you will overtake a woman pack-carrier, her skirts tucked up to her knees, and below the skirts, in prominent view, great knots and masses of corded muscle, which form her not graceful, but very useful, underpinning. Ask her how much weight she carries, and you may get the answer, as if it were a child's load, "ocho arrobas, no más,"—equivalent to, "only two hundred and twenty pounds." As you catch sight of her wrinkled face, you may thoughtlessly remark that it is a heavy load for one of her years ; her

MAGDALENA RIVER STEAMERS.

answer is apt to be: "You should see my grandmother; she does carry heavy loads; I am not full-grown yet." This is said with so injured an air that you ride on wondering why you had not remembered that a woman has a right to be touchy about her age, even if she is not dressed in the height of fashion. As to the grandmother, and the probability of her still being able to carry burdens in this

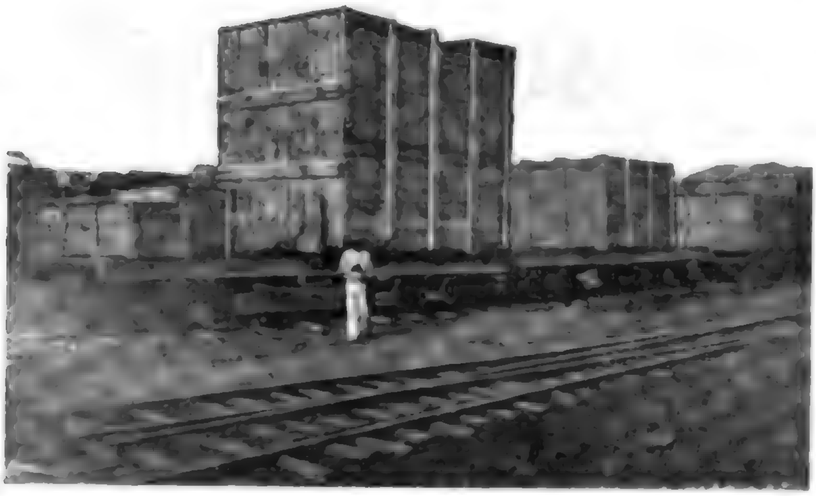
AN OCEAN STEAMER LYING OFF BARRANQUILLA.

THE PUERTO COLOMBIA PIER, 4000 FEET LONG.

world, you are apt to be strongly of the opinion that the pack mulish old lady has drawn entirely on her imagination ; but do not be too sure of that, for the glaring tropical sun brings wrinkles quickly, and, where women are frequently mothers at fourteen years of age, a great-grandmother may still be a very active member of society.

Is this sort of freight-carrying expensive? Rather! A twelve-arroba, 330-pound package, which is generally the maximum for men, as a nine arrobas is for women, may cost $150 for one hundred miles, or $10.18 paper per ton per mile.

THE HEAD OF THE STEEL PIER AT PUERTO COLOMBIA (SABANILLA HARBOR).



THE LARGEST PACKAGE HANDLED BY THE BARRANQUILLA RAILWAY.
(Box measured 1934 cu. ft. and weighed about 8 tons.)

Lighter packages, which a mule can carry, pay from $0.65 to $3 paper per ton-mile, according to the condition of the road, health of mules, etc.; but, when the weight of a single package reaches a ton, it is better not to ship it, for the method of transportation in that case is to place the load on pieces of wood, like sled-runners, and haul it by a rope attached to a windlass, or capstan, fixed in the road a short distance ahead.

As the roads are narrow, crooked, steep, slippery, and often near the edge of a precipice, it is easy to imagine that this sort of traffic is tedious and costly. In fact, the government is perhaps the only party rich enough to indulge in it. There are records of pieces of mint machinery being five years on their way to an interior city, one hundred miles from the Magdalena river, and in that time they had been dragged but half the distance at a cost of nearly $15,000. This variety of rope haulage costs about $30 per ton-mile.

THE ENGLISH HOTEL AT BARRANQUILLA.

MULE DRIVER AND WOOD SELLER.

In carrying rails from the Magdalena river to Bogota, for a small railway to be built there, it was at first attempted to allot two short rails to each mule, letting the ends of the rails drag on the ground behind the mule. This plan was soon abandoned, because the ends of the rails wore off badly on the ground, before they reached their destination. Then a tandem team of two mules was fitted out with a twenty-foot rail, weighing thirty-five pounds per yard, on each side of them. They soon learned to keep step beautifully, as it behooved them to do. A contractor was recently obliged to finish a piece of railroad by a certain date, and found that he lacked twelve thirty-foot rails. He had no time to import them, but managed to buy the required number from a neighboring railroad, less than ninety miles away; as the roads were not of the best, he was obliged to pay $1,500 for the transportation of those twelve rails.

Let us trace the cost of carrying a sack of coffee, which weighs about one-sixteenth of a ton, from the plantation on which it is grown to the seaboard. As the best coffee grows at not less than three thousand feet above sea-level, it must go an average of about eighty miles on mule-back before reaching the river; this means $8.50 paper for the mule. Supposing it to travel five hundred miles on the river, that freight will be $1.92 to Barranquilla; then eighteen miles of railway travel costs $0.33; total, $10.75 in Colombian paper, or, at the usual exchange of 150 per cent. premium, the total cost of 598 miles' travel of our sack of coffee is $4.30 in gold, making an average freight per ton-mile of $.01146 gold. From the coast to New York the freight is $0.40 for the sack, or $0.0032 per ton-mile.

We have here the startling fact that to carry a sack of coffee 2,518

WATER TRANSPORTATION IN COLOMBIA.

miles by river, railroad, and ocean steamer costs but 38 per cent. of what it does to carry the same sack eighty miles on a mule Yet in this we see another instance of the proneness of human nature to strain at a gnat, while the camel goes down as a matter of course. The river steamer, the little railway, and the ocean freighter are looked on by the average Colombian as extortioners which, by their high rates, are robbing him of his hardly-earned profit; but the sturdy little mule is his tried and true friend, and he is begrudged nothing.

In passing over almost any mountain mule road, if you are a stranger to the path, your baggage-mule-driver is apt to enliven the way with anecdotes of experiences of other travellers who have passed that way.

Here on this narrow slippery ledge Don Pacho ......'s baggage-mule struck his up-hill trunk against the corner of that rock, and over he went into the gorge below. Don Pacho was just returning from Europe, and his trunks were too large for this road. In the crotch of that tree one trunk was found; in that thicket, far below, are still some pieces of the other trunk; and all the way down that dizzy slope the contents of the trunk had been scattered; while in the bottom of the ravine the mule was found quietly nibbling leaves, as if he had gone through the whole per-

THE WOOD MERCHANT.

formance just to get at them. In passing close to a muddy stream, you are warned to keep up on the steep bank, at the risk of a fall, for in that miry ooze below you rests a pack-mule with his two sacks of coffee still on his back. For a day or two after his fall his ears could still be seen sticking out of the mud, but a freshet of a stream had covered him up, and probably sunk him deeper. "How did he get there?" "Oh, the most natural! Two pack trains meet themselves here on this slippery bank, with the black mud without bottom below. All try to go themselves up above the others, one falls himself against the other, and that one rolls himself over, and finds himself in the mud, with the head for the water. He raises himself, and falls himself forward, twice or three times, and—adios, mula! The mire swallows him."

Who can blame the Colombian for sympathizing with the mule? But let the traveller go on a river steamer, and listen to the deck hands tell the history of each bend and rapid. Here the mud-drum of the Elbers burst, killing four men; here the Montoya, the pride of the river, was sunk by a collision; there the Bolivar, the largest of them all, was run upon a hidden sand-bar, to save her freight and passengers, when she was found to be fast sinking from having struck a sunken snag. There the Medellin's boiler blew up, and the death-rate ran high; this is the "Friar's Bend" of the river, because here a steamer blew up, as she was going up the swift current, and on that cliff was found the body of a friar, one of the passengers.

POTTERY GOING TO MARKET.

The mule road has not a monopoly of disasters. Has the railway nothing to tell? Yes, as much as any mule road, and, besides, it is ridden by an "old man of the sea" in the shape of legislation difficult to get rid of;

COLOMBIA FREIGHT-CARRIERS.

yet there is a general complaint through the country against the high railroad freights. Let us examine those of the Barranquilla railway.

The average freight charge per ton during the past year was $6.67 paper, or $2.67 gold, making fifteen and a quarter cents per ton-mile, which, compared to the average on United States railroads,—$0 0084,—seems excessively high; but there are various reasons for this. In the first place the railway supplies the labor which handles all import cargo in the custom house, weighs it, moves it for inspection, and delivers it to the consignees; for this service, it is allowed to increase its maximum tariff eighteen per cent.

The government receives about three per cent. of the gross freight earnings, besides a State tax amounting to about the same per cent. of expenses as that constituted by the railway tax in the United States. Deduct the first two items, and the average freight-rate amounts to $2.1825 per ton, or 12 cents per ton-mile, which is still fourteen times the average charge in the United States. But the average haul of the freight in the United States is 122 miles, while on the Barranquilla railway it is 17½, making this road's proportion of loading expense seven times as great as that of the United States railways.

The tons of freight hauled one mile, divided by the total number of miles of railroad, gives, for the United States, 473,500, and, for the Barranquilla railway, 56,700. That is, the average railroad in the United States does eight and a third times as much freight work as the heaviest traffic-carrying road in Colombia.

Comparing the passenger traffic in the same way, the average United States road carries twenty-nine times more. Eleven per cent. of Colombian passengers are government officials, who go free to the

number of twenty in one day, and forty-five per cent. of the paying passengers pay but twenty cents paper for a round trip of thirty-four miles, with sixty-six pounds of provisions. This is equal to $0.00235 gold per mile,—but little more than one-tenth of the average United States charge.

Colombian receipts from passengers and baggage are 4.6 per cent. of the total receipts, while those of the United States average 29.16 per cent. The highest through passenger-rate in Colombia is equivalent to $0.0925 gold per mile, or four and a half times the United States rate. Colombian operating expenses, reduced to gold, are considerably in excess of those of the average United States road, as might be supposed from the shortness of the road. Are these rates exceptionally high even for the tropics? No. One road of thirty-two miles in length charges four times as much per ton per mile as the Barranquilla charges, and another, thirty four miles long, charges five times that rate.


COLOMBIAN TRAMPS.

The great drawback to railroads in Colombia is that they must receive paper for their services, and pay their debts in gold. There is also the constant possibility of a revolution which may at least stop traffic, small even in time of peace.

Has this road no opposition? Yes, a road sixty-five miles long was built from Cartagena to the Magdalena river, but it is not a financial success. For many years there have been schemes on foot to open the mouth of the Magdalena river to navigation by ocean steamers, so as to bring the cargo directly to Barranquilla; but to the average engineer the enthusiasm with which those who have had no experience with such work advocate its immediate execution is really funny.

It is a well-known fact that, where a jetty or dike is built to narrow a stream, in order to deepen its channel, a new bar will form below the jetty, unless there happens to be a narrow channel there already, very deep water, or a strong cross current, capable of carrying away the river sediment.

The west bank of the Magdalena has been prolonged out to sea by a deposit of sand which it continually brings in its muddy current, making a sweeping curve of narrow sand-bar five miles long. The sand is deposited on the west side of the current only, because the almost constant trade winds, or gales, blowing from the north-east, force the current to that side. As the sand spit grew, the wind bent it to the south-west, so that, at its end, it is nearly parallel to the direction of the wind. Probably, when the river has built a considerable strip parallel to the trade wind, it will be satisfied, and will spread its mud more evenly on the ocean's bottom.

Fifty years ago there was a belt of land on the east side of the river, extending to within a mile of the present terminus of that on the west side; that is, the river ran four miles into the Caribbean sea, enclosed on each side by a natural dike of land. At that time, as well as now, there was a comparatively shallow bar at the mouth of the river where it met the sea. As the land on the east side of the river was gradually washed away by the heavy surf of the north-east gales, which last with more or less force during six months of the year, the mouth receded, and the bar with it, until it reached its present position. Is it not reasonable to suppose that jetties would have to be extended farther even than the natural dikes, which the river itself undoubtedly built in its leisure time, in order to have a permanently deep outlet into the sea?

Even if we imagine the construction of a series of jetties four miles long in rough sea, it takes a wilder freak of imagination to think of maintaining such work against the heavy surf so common there. That a channel for twenty-four-foot-draft steamers could be made and maintained for any less than the cost of the Mississippi river channel does not seem possible, and it would probably cost much more; but, at the rate of cost of that work, the maintenance, and six per cent. interest on the capital, would amount to more than double the total receipts of the railway.

When a steamer of light draft manages to go up the river, she cannot reach Barranquilla, because a low, swampy island keeps her two miles from the town; there being no wharf, pier, or road, she must use barges to unload. This causes so much delay that a pier and short railroad are a necessity. To make this permanent would be expensive, as the river bank is low and easily washed. The result of this

expense would be only the exchange of a railroad eighteen miles in length for another two miles in length, and to the average mind the advantage, considering the expense and traffic, is not apparent.

And yet we have much literature on the subject. One of the United States consuls, not long since, was so convinced that the Barranquilla Railway was the great retarder of the progress of the country that he reported very enthusiastically in favor of opening the mouth of the river at once. It was the "burning question." "In five or six years, at the farthest, the present facilities will be entirely inadequate for the commerce of the country; even at the present moment, there is no accommodation for the export of timber, log wood, ivory nut, railway sleepers, and cattle (as they cannot resist the extra cost of the railway freight), or for the exportation of heavy pieces of machinery, etc." As the gentleman had been transplanted from the west less than two years, he had not yet outgrown the boom fever. When I first went to Colombia, nearly nineteen years ago, I met several foreigners who were afflicted with this disease; most of them are under the ground, some have left the country; but all who remain have long since had that kind of fever thoroughly eradicated from their systems. In fact, for a complete cure of any form of boom complaint I can conscientiously recommend a residence in this climate. The following table of value of exports from Sabanilla, including gold and silver, gives the highest and lowest points which the traffic reached between 1874 and 1894:

1874	$ 8,764,786.
1875	9,082,040.
1877	6,800,145.
1881	12,399,609.
1885	3,807,851.
1891	14,409,290.
1894	10,781,075.

The fluctuations are caused partly by revolutions, which nearly paralyze traffic for a time. As the export traffic has really increased less than twenty-five per cent. in twenty years, and the railway has rolling stock sufficient to carry three times the present traffic, I think it may hope to still be able to cope with what may come for a few years more.

As for the freight-rate being too high for lumber, the present price of rough sawed lumber at the mill in Colombia is $150 paper per 1,000 feet, board measure, or $60 gold, while the freight-rate is $6.40 paper per 1,000 feet. The cost of the lumber is high, before the railway receives it, as Georgia yellow pine shipped *via* New York costs but $91.40, paper, independent of import duty. Still 168 tons were

shipped last year. Of log wood 329 tons were carried. The invention of celluloid discouraged the ivory-nut trade, but in 1895 that freight was 621 tons. The general price of fat cattle in Colombia is equivalent to $0.048 gold per pound on foot, or about 9½ cents per pound of useful meat, while the export price of salted United States beef is $0.056 per pound. What inducement is there to export live cattle from Colombia, even if the railroad should transport them free? Railway sleepers at $1.50 gold—the price of the export tie delivered in Colombia—would have great difficulty in finding a purchaser anywhere, except at the Isthmus of Panama, where the demand is limited.

As for our inability to transport heavy pieces of machinery, etc., the heaviest single package of which there is record weighed 9 tons, the longest package measured 45 feet, and the largest 1,934 cubic feet. Nothing presented for transportation has ever been refused by the railway, so it cannot be blamed for not having carried larger or heavier parcels. In its yard in Barranquilla are pieces of costly machinery which have been waiting for years for the owners to claim them, but mules large enough to carry them have not yet been found. Any person who has seen the system of transportation in the interior would consider the statement that any railroad could not carry large enough packages for the needs of the traffic a huge joke; yet such has been the United States consular system that men come and go without seeing enough of the country to have an idea of its needs, and expect to find a New York Central Railroad built for a traffic which would require on that road but one round-trip of a freight train in twelve days, and one passenger train making a round trip every ten days. It is to be hoped that, with the civil service improvement, consuls may have an opportunity to stay in foreign countries long enough to accumulate useful information.

The hindrance to traffic in Colombia is not the railroad or steamboat, but the obstreperous, long-eared mule. At present, a ton of freight for the capital may be brought from Europe, 5,500 miles, and carried up the river, 600 miles, for $24; but his royal highness, the mule, must have $64 gold for carrying the same freight ninety miles, and even then it must be in packages of size and weight to suit him, or he will not deign to touch it.

THE GROWTH AND DEVELOPMENT OF THE STEEL RAIL IN AMERICA.

By H. G. Prout.

II.

THE rails designed under the influence of the Chanute-Sayre school were developments of the idea that the metal ought to be put where the wheel-wear comes, which seems a reasonable notion, and which naturally prevailed until people began to collect, analyze, and generalize many of the facts of service. It gradually became apparent, to the astonishment of the world, that these heavy rails with big heads actually did not wear as well as the early steel rails of light section with small heads. When it was found that the old John Brown rails of the Welch section would wear out two of the modern deep-headed rails, there was endless speculation as to the reason. A favorite doctrine with many really good engineers was that the light sections were flexible, and gave way under the wheels; did not offer so much resistance; did not receive blows as an anvil receives them; and so on.

Slowly the facts were established that a very small percentage of the rails that failed did so from the wearing off of the surface on the top. They failed because they wore rough, or because they broke; the heads were split down, and the ends battered out. They did not stay in the track long enough to wear out. Studies of etched sections of broken rails, investigations into scrap-heaps, chemical analysis, and physical tests finally established the fact that the new rails were physically softer, irrespective of chemistry, than the old rails with small heads; that they were less homogeneous, and that the metal was not so thoroughly worked. Pipes and blow-holes in the ingots remained as flaws in the interior of the rail-heads. It came to be well recognized also that the great mass of metal in the head cooled much more slowly than the thin flange; consequently, in the final passes, the head was worked at a high heat, and the flange at a low heat. The slow cooling of the head established curves, and it was impossible to give the rail just the camber that would cause it to cool straight. Therefore the rail had to be straightened in the mill by gagging. But gagging is a cruel process; it is likely to put two little curves into the rail in place of one big one. It forcibly changes the tension in the material, and the rail leaves the mill straight, not because it is its nature to be straight, but because it has been distorted

into approximate straightness, full of all that contrariness which engineers call internal strains. So the next thing that happened was the restoration in the track of some of the crookedness taken out by the gagging, and this in turn led to breaking under the blows of driving-wheels.

Then came forward the school of doctors headed by Dudley, Hunt, and Hawks, who insisted that Holly and Welch were nearer right than the later designers, and that the rational form of rail-section was one in which the weight of metal in the two main members is balanced as nearly as may be. Dudley's 80-pound rail of 1883 (Fig. 11) had 45 per cent. of the metal in the head, 20 per cent. in the web, and 35 per cent. in the flange. Hawks's rail of 1889 (Fig. 12)—also an 80-pound rail—had 42 per cent. in the head, 22 in the web, and 36 in the flange.

For a number of years this part of the principle of rail-design was a matter of lively discussion. Mr. Dudley and Mr. Hawks thought, and worked, and produced rails, and wore them out, and did not say very much, but what they did say was to the point. Captain Hunt was persistent and insistent in his brief and pungent papers before the societies. In 1889 Captain Hunt had brought out his series of sections, the general characteristics of which are shown in the Hawks section, and in 1893 the committee of the American Society of Civil Engineers brought out the series of standard sections varying by 5 pounds and running from 40 pounds up to 100, the general principles of which are seen in Figs. 14 and 15. Here the distribution of metal is practically identical with that of Hawks's 80-pound section. The crown radius is 12 inches, the upper corner radius is $\frac{6}{16}$ of an inch, and the width is $2\frac{7}{16}$ inches. The head is broad and thin. This committee consisted of eleven members of the society, all prominent, and included Mr. Hawks and Captain Hunt, who had the satisfaction of seeing their ideas prevail, but not without a struggle. There are several stout representatives of the older theories on the committee, and the ultimate agreement was not reached without a good deal of the most careful and solid discussion and consideration. When I say that this series is the standard of the American Society of Civil Engineers, do not misunderstand me. It has been the policy of that society, not to fix standards, but simply to recommend them. What the society did in this case was to collect material, encourage discussion, and approve, finally, the set of sections presented by the committee, and the use of these is now the practice recommended by the society. Really, they must stand and fall on their merit.

But there is another element that enters into the design of the rail

section—its stiffness as a beam; and stiffness is very important. I am inclined to think that, if the road could be made absolutely unyielding, the springs of the vehicles providing the elasticity, the best results would be had. If the track could be as smooth and relatively as stiff as a planer bed, there would be a saving in the cost of maintenance of track and machinery, and in coal-consumption. The stiffer the rail, the less the creeping due to the wave which runs ahead of the wheels, the less the wear of the ties due to this motion; the less the destruction to track and running-gear due to the pounding of the wheels; and the easier the hauling of the trains. Mr. P. H. Dudley, who has made careful measurements of tractive force with a dynamometer, says: "Instead of making rail sections simply heavy, I have made them very stiff, which has reduced the deflection, or wave motion, under each of the wheels. Comparing the resistance of the Chicago limited express on stiff 80-pound rails with that on 65-pound rails, it makes a difference of 75 to 100 h. p. per mile." He designed some rails of 105 pounds nearly 100 per cent. stiffer than his 80-pound rails, and estimated that on fast express trains he would save nearly 200 h. p. per mile as compared with a worn 60- or 65-pound rail. If we admit, then, that it is desirable to make the rail as stiff as we can with a given weight, it follows that the section should be such as to give relatively great depth, to distribute the metal somewhat equally between the members, and to put the strained fibres as far as possible from the neutral axis.

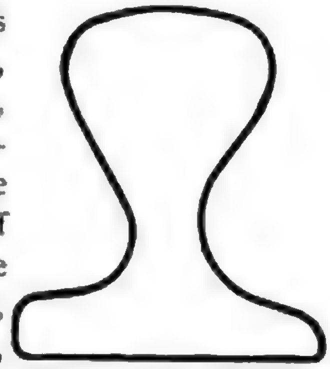


FIG. 1. IRON, 84 LBS., 1875.

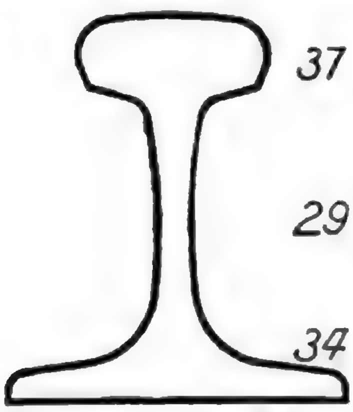


FIG. 2. HOLLY, 58 LBS., 1858.

Now let us again go over this matter of the small railhead, for there are some points which I wish to make very clear. They are the controlling elements in the modern theory.

First, it gives with the same weight of metal a stiffer section, because the beam is deeper and the members have more nearly equal areas.

Second, the small-head rail cools straighter, for the masses of metal are more

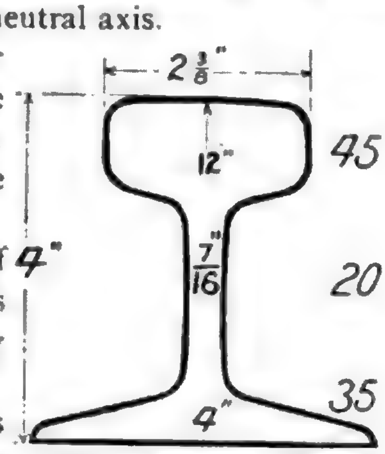


FIG. 3. WELCH, 53 LBS.

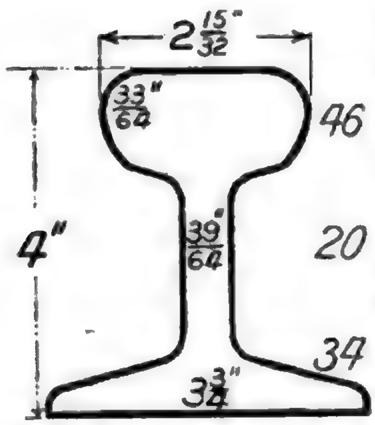


FIG. 4. MANY ROADS, 60 LBS., 1870.

nearly equal; thus we get rid of internal strains, and of the kinks introduced by the gagging press.

Third, with the same chemical composition we get a harder and tougher head, for the metal is worked down more in the rolling. The forging effect is obtained all through the mass. This, too, helps to eliminate the defects of piped ingots. There is a better chance that the walls of the cavities will be closed and the traces of pipes and blow-holes disappear. But one should not rely too much on this. The best way is to see that the ingots are sound to begin with.

Fourth, the reduced mass in the head leads to the very important result of making the final passes through the rolls at a low temperature. Steel is a beautiful and useful metal, but it must be treated with great judgment. Robert Hunt, whose life has been spent in trying to get good steel rails made (and it has been a life of great energy directed with singular intelligence), once said: "The metal commonly known as steel is almost as sensitive to treatment as a woman. It will stand any amount of punishment, if administered by judicious hands, and unexpectedly rebel, if a less amount is given with indifference." I think I might make this further parallel—about steel and women the more you know the less you know. But the modest and painstaking and persistent inquirer can learn some things about steel at any rate. Such an inquirer has been Mr. Metcalf, of Pittsburg, past president of the American Society of Civil Engineers, and past master in the art of steel-making. In a beautiful paper on steel, read before the American Society of Civil Engineers in 1887, Mr. Metcalf says: "It is well-known that the whole structure of the ingot or casting varies decidedly with the temperature at which the metal is poured. It is not so generally known that in every piece of steel that is in existence to-day there is a sure record of the last temperature to which it was subjected, as well as of the manner in which the steel was worked. For every variation of heat that is visible to the naked eye, there is a corresponding variation in structure which is equally visible to the naked eye if the record be opened by

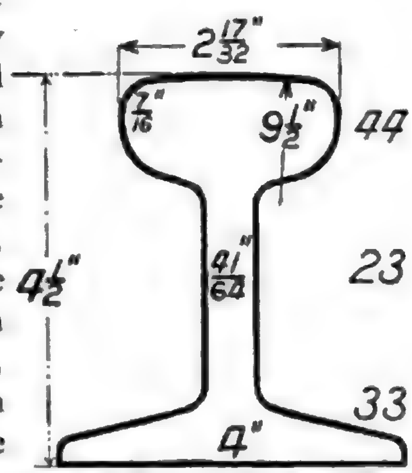


FIG. 5. P. R. R., 67 LBS., 1870.

fracturing the piece. There is also a different specific gravity for each difference of structure. There is, of necessity, a permanent internal strain for every variation in specific gravity, because each change in specific gravity means a corresponding change in volume. These strains vary from the slightest up to those that produce rupture. A piece of 58 carbon steel will vary in specific gravity from 7.844 in the bar finished at ordinary red heat to 7.818 in the bar cooled from a scintillating heat—a difference of .026. A bar of 1.079 carbon under the same conditions will vary in specific gravity from 7.825 to 7.690,—a difference of .135. This shows that for a double quantity of carbon we have five times the difference in specific gravity, due to an equal difference in temperature. Every piece of steel is at its best in all physical properties when the grain is in the finest condition possible, or its crystals are the most minute and uniform size. The largest crystals and the coarsest and weakest structure are formed when iron and steel are allowed to cool slowly and in a state of rest, and the finest crystals and the best structure can only be formed by quick cooling and the violent agitation of the hammer or of the rolls."

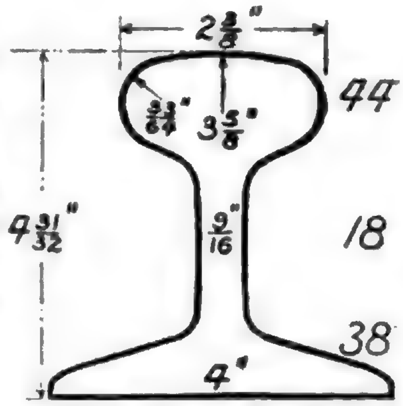


FIG. 6. D. L. & W., 61 LBS., 1874.

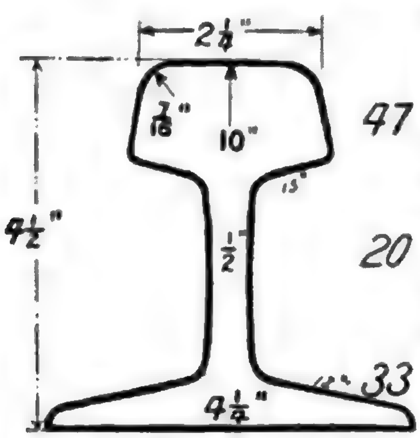


FIG. 7. CHANUTE.

All of this means that, if we want a compact, hard, tough, homogeneous steel, its final working must be at a low temperature, or, as Mr. Metcalf says, it must cool quickly and during the violent agitation of the hammer or the rolls. This means also that the harder the steel is chemically,—that is, the higher it is in carbon,—the greater the effect of this low temperature at the final passes. And here is one of the occult, but unquestionable, benefits of making the head of the rail small,—a benefit which has been suspected only in very recent times; the mass is so small, relatively, that the metal cools quickly, relatively, and cools while it is still un-

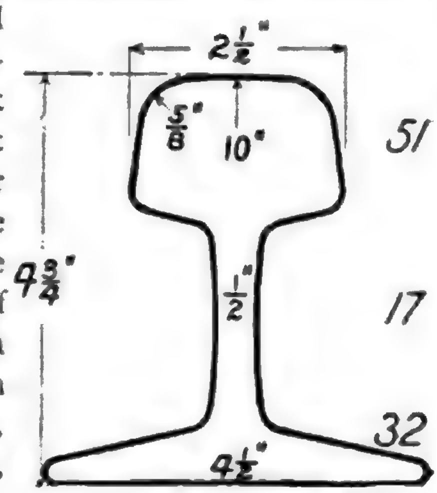


FIG. 8. P. R. R., 75 LBS., 1885.

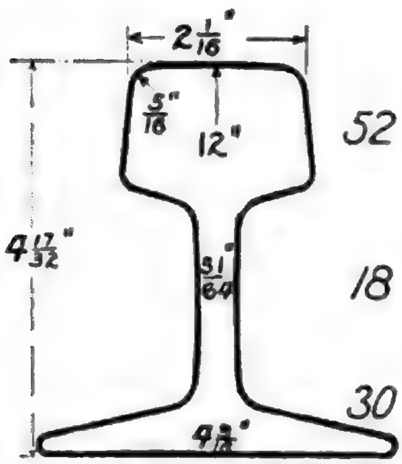


FIG. 9. C. C. C. & I., 65 LBS., 1885.

dergoing the agitation of the rolls. It becomes, therefore, dense, compact, and homogeneous. All of this is illustrated in the story of the 95-pound rail designed in 1890 by Mr. P. H. Dudley for the Boston & Albany. The chemical specifications required 60 points of carbon, 80 to 90 of manganese, 10 to 15 of silicon, not more than 6 of phosphorus, and not more than 7 of sulphur. The proportion of carbon was thought very high for American practice, and there was some doubt as to the possibility of getting a tough steel with so much carbon. Thanks to the careful manipulation, but still more to the intelligent proportioning of the section, a steel, not only chemically hard and physically hard, but remarkably tough, was secured. Two thousand pounds falling 20 feet rarely broke the specimens, while many hundreds stood from two to four blows of 2,000 pounds at 30 feet with supports 4 feet apart. When tested under the drop falling on one side, the lower edge of the flange gave an elongation of 16 to 18 per cent. Specimens from these rails gave a limit of elasticity of 55,000 to 60,000 pounds. This was not only hard, but tough, steel. The New York Central had already adopted the Dudley sections as standard, and, as a result of the experience with the Boston & Albany 60-carbon rail, the New York Central has now adopted 65 to 75 points of carbon for its 100-pound rails and 50 to 60 for its 75- to 80-pound rails.

While the most important principle fought for in this later battle of the sections was such a distribution as would insure more thorough working down of the metal in the head by making it thinner, and would insure more nearly the same rate of cooling, and would make the final passes at a low temperature, and would give a stiff beam to carry the load, there are minor points of considerable importance.

I asked attention to the matter of the corner radius and the slope of the sides of the head. The large corner radius of half an inch or thereabouts, shown in the earlier sections, was probably adopted without any very careful consideration. At any rate, I have

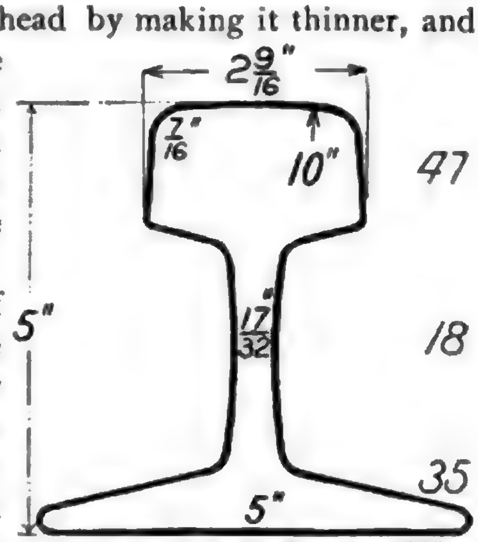


FIG. 10. P. R. R., 85 LBS., 1888.

not discovered the reasons for it. But some years ago a very elegant theoretical reason for it was brought forward. We had the fact, so we must have the theory. It was held that the upper corner of the rail-head and the fillet joining the tread of the car-wheel to the flange of the wheel should coincide, or nearly so, in radius of curvature, in order to give the maximum bearing surface of the one against the other, and to prevent the cutting out of the fillet of the wheel by the sharp upper corner of the rail-head. At first sight this seems plausible, and the theory was soon applied to the side of the rail. At first the rail-head was flared to increase the bearing surface for the fish plates underneath the head, —certainly a laudable practice; but soon the doctors discovered a higher theory to fit the facts,—namely, that, it being a good thing to have the curve of the fillet and the curve of the upper corner of the head fit, it was a still better thing to have the fit extend down the side of the rail, so that the flange of the wheel would come in contact with the side of the rail-head for a considerable depth, thus still further increasing the wearing surfaces, brought in contact. This sounded plausible, and there are to this day intelligent and responsible engineers who insist upon having rails rolled with a considerable outward flare of the head in order to diminish the flange wear of the wheel, and the section shown in Fig. 18 was actually rolled ten years ago. But the fallacy of this theory is easily seen. The friction between the wheel and the rail is changed from rolling friction to sliding friction. So long as the curve of the fillet and the curve of the rail corner come in contact only on a line high up, near the tread, the friction between the two is practically a rolling friction; but, as this contact extends down the side, the flange of the wheel grinds against the side of the rail, and the hard, chilled iron becomes a beautiful tool for cutting away the side of the rail. Furthermore, this flange friction is a serious element in the sum of the resistances of the train.

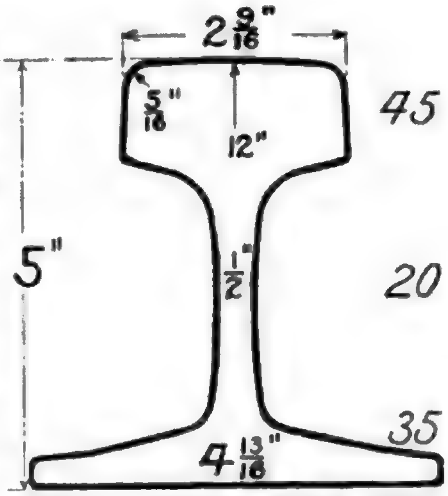


FIG. 11. DUDLEY, 80 LBS., 1883.

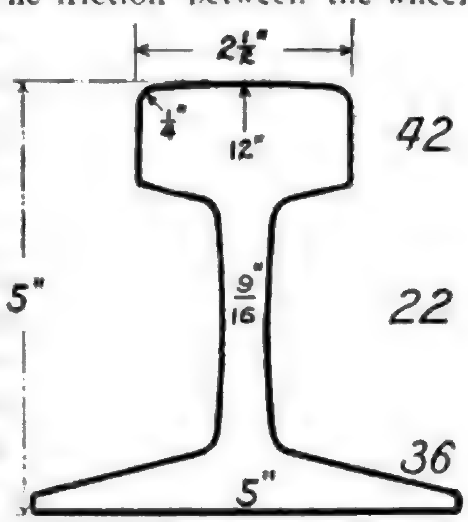


FIG. 12. MICH. CENTRAL, 80 LBS., 1889.

The 12-inch-crown radius has been returned to in the later designs, in order to increase the bearing surface of the wheel on the top of the rail. For years there was a tendency to reduce the crown radius. Mr. Sandburg, an intelligent and influential Swedish expert practising in London, whose work has had much effect on modern rail sections, got down to a 6-inch radius. I should say that 10 inches is the most common in American practice. Recently, however, 12 inches has prevailed, and indeed was considerably used before the Dudley-Hawks-Hunt sections were much talked of. Mr. Dudley uses 14 inches for the crown radius of his heavier sections.

There are those who would make the top flat; among these is Mr. D. J. Whittemore, chief engineer of the Chicago, Milwaukee & St. Paul. For this there are two chief reasons. With a greater area of contact, there is greater adhesion between the driver and the rail, and, further, as the pressure is distributed over a greater area, there is slower wear of the rail and the tire. These points seem obvious; they are matters of observation as well as of theory. With the recent broad heads, with 14-inch crown radius, the life of driving-tires is observed to have been increased, and I do not doubt that the life of the rail also will be increased. A number of experiments have been made, especially by Mr. Chanute and by Mr. Whittemore, and later by Prof. J. B. Johnson, to ascertain the static pressure of a locomotive driver on the top of the rail. This has been done by jacking up the wheel, painting the rail, letting the wheel down, and observing the shape and size of the figure produced. It is a rough ellipse with the long axis across the rail and with an area of from $\frac{6}{10}$ of a square inch to $1\frac{1}{4}$ sq. inches. Mr. Chanute thought that he got static pressures of more than 80,000 pounds per square inch, and Prof. Johnson got 160,000 pounds. But this gives little notion of the effect produced by the delivery of the blow of a driving-wheel in rapid motion on so small an area. It was the prevailing design of rail-head with a sharply-curved crown, tending to reduce the contact between rail and wheel as nearly as possible to a mathematical point, that led Mr. Whittemore to say that every inch of rail contained a blunder.

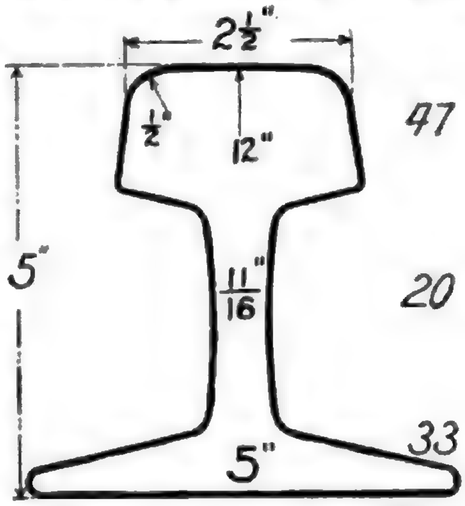


FIG. 13. P. & R., 90 LBS., 1888.

We will now consider the chemistry of the steel rail. In the early days not much attention was paid to chemistry. Early rails

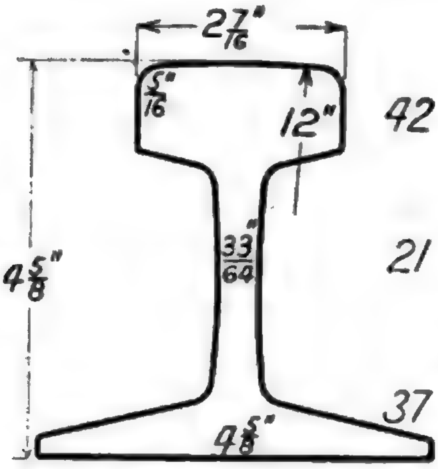


FIG. 14. AM. SOC. C. E., 70 LBS.

which wore remarkably well showed, on analysis, a wide variation. Carbon ran from 24 points to 70 points, and phosphorus from 8 points to 16, but the mill processes were slow and careful. The heads were small; the rails were worked at a low temperature; they came out physically hard and tough. It did not make much difference, therefore, about the carbon, or, indeed, about the other chemical ingredients. As time went on, and the demand rose, and prices fell, the pressure for big mill outputs grew. Less care was taken; rails were finished hotter, and the quality fell off; and then the chemist assumed more importance.

About 1878 Dr. C. B. Dudley, chief chemist of the Pennsylvania Railroad, announced that soft rails were best. His studies were from twenty-five samples of rails taken out of the track, and his critics said that this was too small a number of observations to serve as a basis for a general law. In 1880 or 1881 Dr. Dudley came forward with a second paper, being a long, carefully-written, and ingenious report to Mr. Ely, superintendent of motive power. In this he gave the result of studies on sixty-four rails taken from the track, and his conclusions were that these studies confirmed the results of his observations on the twenty-five rails of three years before,—namely, that soft rails (rails low in carbon) wear longer than hard rails. The practical outcome, so far as he was concerned, was that he recommended for the Pennsylvania Railroad a rail specification as follows: Carbon, 25 to 35, aiming at 30; phosphorus, 10 or less; silicon, 4; manganese, 30 to 40, aiming at 35.

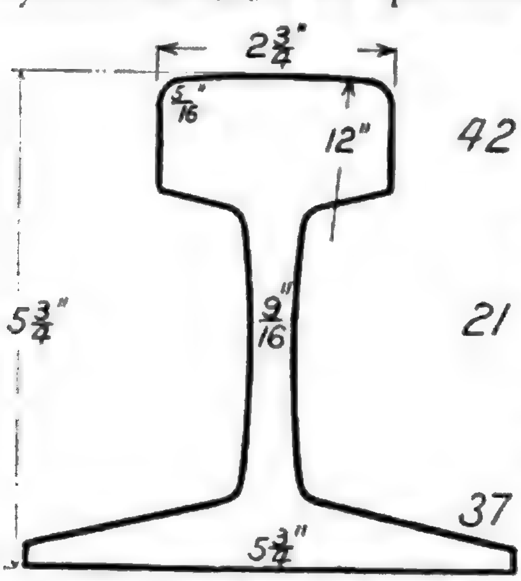


FIG. 15. AM. SOC. C. E., 100 LBS.

This proposition—that soft rails wear better than hard ones—was supported by ingenious reasoning and a formidable display of figures, tabulated in various ways, and really had a good deal of effect on American practice for some years; but I doubt if carbon is ever specified now as low as 30 points. Indeed, I doubt if the Pennsylvania Railroad ever had many rails rolled with so small a

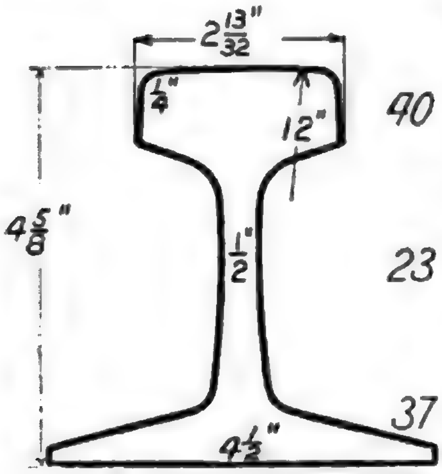


FIG. 16. DUDLEY, 65 LBS., 1890.

proportion of carbon. Certainly, the Dudley specification soon gave way to
40 a specification calling for 30 to 50 points
of carbon, and giving a wider range in all chemical ingredients.

But the Dudley specifications made
23 people timid about a high carbon. The fallacies of the theory were pointed out early, but there were good reasons why it was convenient for people to think
37 that soft rails would wear better than hard ones. Ores high in phosphorus are cheaper than ores low in phosphorus, and, with a low carbon, more phosphorus may be used. Then, with thousands of miles of unballasted and badly-drained track, it is desirable to have a soft and tough rail,—that is, a rail which will not break easily; and this need is especially desirable in a climate like that of the United States, subject to severe frosts and violent changes of temperature. Not that a rail breaks because it is cold, but because, in the freezing and thawing of the ground, the supports become uneven. It was more important for many poor roads to have a rail that would not break than to have one that would wear well. Thus, the soft-rail theory had considerable vogue.

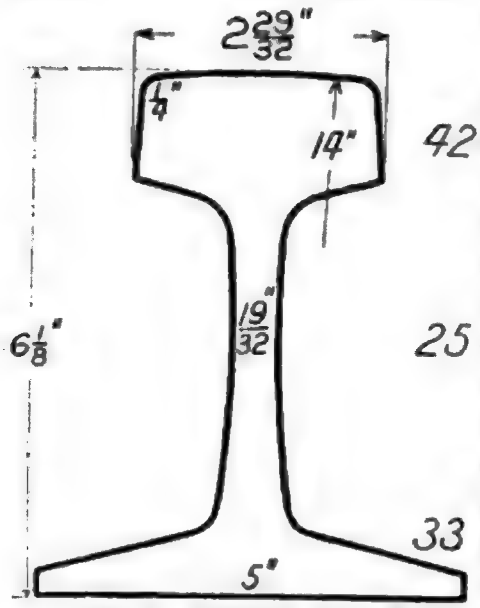


FIG. 17. DUDLEY, 100 LBS.

But the theory was not borne out by experience, nor was it demon-
42 strated by Dr. Dudley's figures. The rails which he considered were not high-carbon rails. In the sixty-four rails there was only one that had more than 60 points of carbon; there were
25 only four that had more than 50; there were only nine that had more than 45; but to-day 50 points of carbon is looked upon as only ordinarily high. A higher carbon is
33 frequently specified, and a rail having only 45 points would not rank as hard. The fact is all of Dr. Dudley's rails were soft rails; they differed only in shades of softness. Furthermore, the differences in carbon were so small that any effect that they could have had would have been obliterated by a dozen other facts in the history or circumstances of the rails. Indeed, the classification had to be so close, in order to divide these rails into two classes of hard

rails and soft rails, that a small error in the work of the chemist who analyzed them would have changed a rail from one class to the other.

I have said that Dr. Dudley's rails were not hard rails; only four of them had more than 50 points of carbon, and only one more than 60. While a carbon of 50 points was considered high ten years ago in the United States, in French practice it would have been very low. The Frenchmen consider no rail hard unless it has 60 points or more of carbon, and they often use 100 points. Mr. Couard, engineer of the Paris, Lyons & Mediterranean Railroad, found, from a study of the rails turned out by four different French mills, that their composition averaged as follows: carbon, 86; manganese, 69; silicon, 15; phosphorus, 5. He compared these with a large number of rails turned out by five German mills, averaging 31 points of carbon and 9 of phosphorus, and found that the French rails wore about twice as long as the Germans.

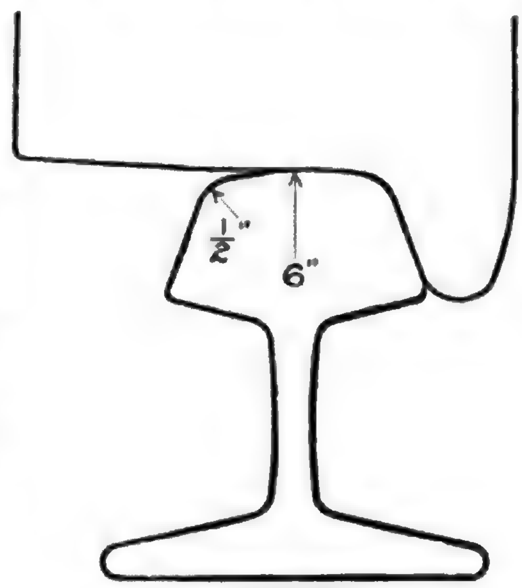


FIG. 18.

But, further, Dr. Dudley's whole comparison might easily have been vitiated, and probably was vitiated, by the difference of service which the rails endured. He made his comparison by total tons carried, leaving out any question of wheel-weights and speeds. But the intensity of the traffic must be considered, as well as the volume of the traffic. A million tons carried over a rail at sixty miles an hour will have a much more destructive effect than a million tons carried at fifteen miles an hour. Furthermore, a million tons carried in heavy loads concentrating the weight on the wheels will have a more destructive effect than a million tons carried in light loads. As a matter of fact, a number of the rails which Dr. Dudley classed as good rails because they had carried their tonnage with comparatively little wear had passed their lives in carrying light loads, while a number of the bad rails had carried twice as many tons per month as any of the good rails.

But all this, without the mill history, without the record of the heat at which the ingot was bloomed and the rail finished, and without its life record in the track, can teach us but little. The fact stands that, together with the increase in weight of section, we see

now a steady rise in carbon specification, and I should not be surprised to see at least 60 points of carbon the rule within a very few years.

It will naturally be asked what measure we have of the life of a rail? How can we tell whether a rail has filled the normal measure of a good rail's life? This is a very hard question. Obviously, its life cannot be measured in years. The section in Fig. 19 was cut from a rail which had been in track eighteen months. Rails from the same lot lived thirteen years in the main track of the same road. The difference was that this unfortunate rail was at the entrance to a great yard, where it had to endure the passage of an enormous tonnage.

But, measured in tons carried, what would be the life of a rail? Here again one may find ingenious speculations. One man says that a rail should carry 100,000,000 tons; another learned man says that it should carry 150,000,000 tons; but, as I have suggested before, this is a question not only of volume, but of intensity of traffic. Again, the life of a rail will doubtless depend somewhat upon the service to which it is subjected when it first goes into the track. If it is used gently for a while, and gets the cold rolling which hardens and toughens its surface before it is called upon to endure extreme service, probably it will wear longer than it would have worn had it been put into intense use at once; and I should not wonder if this was one reason why the early rails wore so well. Capt. Hunt writes to me: "It is fair to expect a trunk-line rail to last ten years. The New York Central has recently taken out rails that have been giving good service from seventeen to twenty years; but these came out of a four-track road." So, I will dodge the question as to how long a rail ought to live.

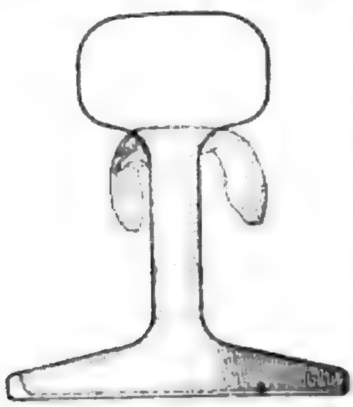


FIG. 19. WORN RAIL.

There is one other matter on which I may venture an opinion,—namely, what is to be the future rail? Fancy sections are invented and re-invented from time to time. Every little while some distinguished or obscure individual comes out with a compound rail, the idea generally being to make it in three pieces,—two lower-flange pieces and the head piece. The objects are, first, not to have to scrap so much material when the head is worn out; second, by laying the three pieces so as to break joints, to get rid of rail joints; third, to make the lower members of a soft and tough steel, and the top member of a hard, but perhaps brittle, steel. I do not hesitate to say that this scheme is nonsense. When we can buy good steel rails at a cent

a pound, we cannot afford to spend much money in making machine-fits and bolting or riveting parts together to save the weight thrown into the scrap-heap, and we have seen that intelligent sectioning gives a rail hard *and* tough. Unless the compound rail is very efficiently made indeed, —much more efficiently than any that has ever yet been put into track,—it will go to pieces in a short time. The last experiment of this sort that I know of was tried in a yard at San Francisco a few years ago, and in a few months the yard sounded like a boiler shop when a locomotive went through it. Steel is too cheap, and good steel is too easily made, nowadays, for one to think of such a device as a compound rail.

Another theory is to make a continuously self-supported rail. This idea has been elaborated with great skill by Mr. Haarmann and Dr. Vietor of the George-Mary Iron Works, in Osnabrück, Germany, and the exhibit of it attracted a good deal of attention at Chicago in the World's Fair. The idea is to make a rail almost eight inches high and almost eight inches wide on the foot,* to be used without sleepers. It is broad enough to get a good bearing in the ballast, and deep enough to make a stiff girder. Moreover, by making the ends unsymmetrical, Mr. Haarmann produces a lap joint, which gives smoothness and stability. Great things are claimed for this rail, and it may come to something. My own notion is, however, that it will not be found economical, at least in the United States, to dispense with wooden ties at the cost of putting so much steel into the rail. Moreover, it will not be found practicable with a longitudinal, self-supported rail to get track so smooth and stable as that given by a reasonably stiff rail on wooden ties. Putting in 16 ties to the 30-foot rail, we get a bearing surface of 85 square feet for 30 feet of track; but, with the Haarmann rail, we have a bearing surface in the ballast of only 40 square feet. With the track on ties we have more than twice the bearing surface in the ballast that the Haarmann rail has. Dr. Vietor was much surprised in the summer of 1893, when he came to accurately measure the deflections of modern stiff American rails in good stone-ballasted track, and he went back to Germany somewhat shaken in his faith in the sleeperless rail. But there is still another objection to this form of rail,—the difficulty of draining the track. The rail supported on ties does not interfere with the drainage. Each space between two consecutive ties allows the water to drain freely away. But with a longitudinal stringer, or with a self-supporting rail and no stringer, it would be difficult to drain the track as promptly and adequately as with ties. For these reasons I question the scientific soundness of the Haarmann–Vietor idea.

* This rail was illustrated in THE ENGINEERING MAGAZINE for April, 1897, p. 50.

Without being ambitious to get the honors and incur the perils of prophecy, I will venture to say that, for many years to come, the standard rail for the United States, and for most of the civilized world, will be much such a rail as we are using now. The section will not differ greatly from what we have now arrived at,—that is, from the Dudley-Hunt Hawks-American Society of Civil Engineers section. The average weight will very likely be higher than it is now, and the steel harder. I should not be surprised to see 100 pounds per yard common, and 80 pounds the average weight, and 60 points the average of carbon. This rail may be 60 feet long, possibly 90. By making it 60 feet long we get rid immediately of half the rail joints,—the most troublesome part of a railroad track. In fact, the Pennsylvania railroad, the Norfolk & Western, and some other roads, are to-day putting in many 60-foot rails.

In all that I have said, I have but scratched the surface of what seems a very important and interesting subject, and I would not have it thought for an instant that I suspect that I have said the last word on steel rails. I thoroughly believe that the principles that I have laid down are sound, and I should, without the slightest hesitation, stake my reputation upon them if I were in charge of a great railroad; yet I may contradict some of them within a year, for there are few things concerning which human knowledge can ever be absolute, and steel rails are not among those things. In this matter, as in most other scientific matters, it is well to remember Disraeli's advice to the young men of the University of Glasgow. "The secret of success in life is to try, to fail, and to analyze your failures." Mr. Whittemore expresses the same idea in more homely words in the apostrophe to the scrap-heap with which he prefaces his witty and learned paper on cylindrical wheels and flat-top rails. He says: "The scrap-heap, the inarticulate witness of our blunders and the sepulchre of our blasted hopes, the best but the most humiliating legacy we are forced to leave to our successors, has always to me been brim full of instruction." If the young engineer will candidly and courageously, modestly and without pedantry, study the scrap-heap, I think I can predict for him a reasonable measure of success. Whether or not he succeeds in getting money or distinction, that way of meeting the problems of life will secure the respect and esteem of the best men about him, which, after all, is the highest success that we can hope for.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

III.—THE NEW PROCESSES BASED ON THE USE OF THE ELECTRIC CURRENT.

ALMOST the first addition made by electricity to the resources of the artificer was the electric deposition of metals, so familiar now that any reference to it seems almost like ancient history. And yet in its day it wrought a revolution in superseding the slow old chemical processes by a method both rapid and cheap. That which before was difficult—*i. e.*, the deposition of a thick, coherent, dense deposit of almost any metal—became simple and easy, so that substantial coatings of metals desirable for their beauty or non-tarnishing properties could be obtained in a practical commercial way.

The result has been the general use of plating in the arts, with great gain in the appearance and durability of a vast variety of manufactured objects. More than this, galvanoplasty has made practicable the reproduction of many things quite beyond the reach of purely mechanical processes,—for example, the duplication of the half-tone plates with which this article is illustrated.

Old as the art is, new applications like the one just mentioned spring up every few years, and it is well for him who flatters himself that "practical electricity" really belongs to the last two decades to stop for a moment and take note of this first great application of electricity to the arts. At present most new applications of the electrotype sort are to the production of novel decorative effects, but in the larger sphere we must not forget that cheap electrical energy has given us cheap aluminum, raising that metal in a few years from the rank of a chemical curiosity to that of a common and useful material, cheap enough for frying-pans and other kitchen furniture, to say nothing of its uses in large construction, which, after all, depend only on skilful alloying. When any other now rare metal becomes specially desirable on account of some particular property, the electric process of reduction is pretty sure to come to the front again, and it behooves the astute manufacturer to keep an eye on it.

In recent years the most important application of electricity to the improvement of our processes of metal-working has been in the line of electric welding.

As is now well known, there are two radically different processes of this sort. One, the arc process developed by Bernardos and

others, simply employs the electric arc as a heating agent. The object to be heated forms one electrode of this arc, while the other may be another object to be heated, or a solid electrode employed simply for convenience. In still another arc process the electric arc is formed between two carbon points close to and parallel to each other, and then driven out into a sort of blow-pipe flame by a magnet parallel to and alongside of or encircling the electrodes. This flame is used much after the fashion of any other blow-pipe flame. In a still newer process the arc is established between the object to be heated and a slightly acid or alkaline liquid in which it is immersed. In this case occurs the tremendously striking phenomenon of a metal bar under water blazing at a white heat, or even melting into fiery drops.

For certain purposes these very beautiful and ingenious methods have proved very useful, but their field appears to be rather limited, ou account of danger of "burning" the metal and general difficulty of regulating the heat, which is really applied on the surface, with sufficient exactness. Extended surfaces of sheet metal can be thus united very readily, riveted joints strengthened by welding, blow-holes in castings successfully filled, and other work done which would be exceedingly difficult by any other method. Used in this way, the arc becomes merely a very cheap and enormously powerful blow-pipe for heating the desired material. The danger of injuring the metal by excessive heat must be faced, but there is a compensating advantage in the simplicity of the apparatus and the ease with which it can be adapted to various purposes.

A rather sensational recent application of the arc is to the needs of the up-to-date bank burglar. It is a well-ascertained fact that a powerful arc, taking, say, ten horse-power of electrical energy, will burn a sizable hole through an inch or so of the hardest chrome steel in four or five minutes, evidently saving the industrious burglar much valuable time and laborious, if not impossible, drilling. The process is fully explained and discussed in its practical bearings in the current electro technical journals.

With sufficient energy at command, the arc can be made to burn its way through material which will turn the best-tempered drill, and now and then the mechanic may be glad to take recourse to it for the purpose.

The most extensively used welding process, which often becomes a valuable adjunct to the metal-worker, is the Thomson method, in which the surfaces to be united are brought together and made the path of a very powerful alternating current. The contact furnishes a rather high resistance, and the great volume of current rapidly brings

the surfaces and the neighboring metal to welding heat. The current is led in by clamps having a large area of contact and good opportunity to carry off the heat, so that the heat is practically confined to the region between the clamps and mainly to the vicinity of the abutting surfaces. When hot, the joint is usually squeezed together, forming a complete union, as strong as a weld can be made. The time taken ranges from a few seconds to a minute or so, while the energy consumed may range from a few kilowatts to fifty or a hundred, according to the size of the work. For an example, two iron bars one inch square can be completely welded in three-quarters of a minute by the expenditure of a little less than seventeen kilowatts. The cost of this power, even at the rather stiff rate of ten cents per kilowatt-hour, would be only two cents, and at the rates for which power could ordinarily be produced would be far less.

FIG. 1. LIGHT WELDER FOR SHOP USE.

The main objection to the use of this very beautiful process in general metal-working is the need of special clamps for each particular kind of work. When a great number of welds of a certain kind have to be made, the special machinery is worth while, but this necessity is forbidding in jobbing work. Nevertheless, there are a great many metal-working shops where the electric welder could be used with great advantage. The apparatus required is a course of alternating current of low periodicity, say, 40 to 50 cycles per second, a transformer (usually) to furnish a large volume of current at low pressure, clamps of proper shape to hold the work, and regulating apparatus to control the current used.

Fig. 1 shows a light welder for shop use, containing the transformer in its base and capable of being fitted with clamps of various shapes for welding iron or steel up to perhaps half a square inch in cross-section. Such a machine has a very general usefulness, enabling

breaks to be welded, tool steel points to be welded to machinery steel shanks, punchings to be assembled, pins to be welded in, instead of being screwed or riveted, and so forth.

The cheap and perfect assembling of punchings into forms which would otherwise have to be laboriously brazed or solid drawn is one of the neatest applications of the method. Hundreds of thousands of bicycle pedals are thus made, as well as countless numbers of the reinforces with which the tubular frames are assembled.

Fig. 2 shows another "general utility" welder, in which the

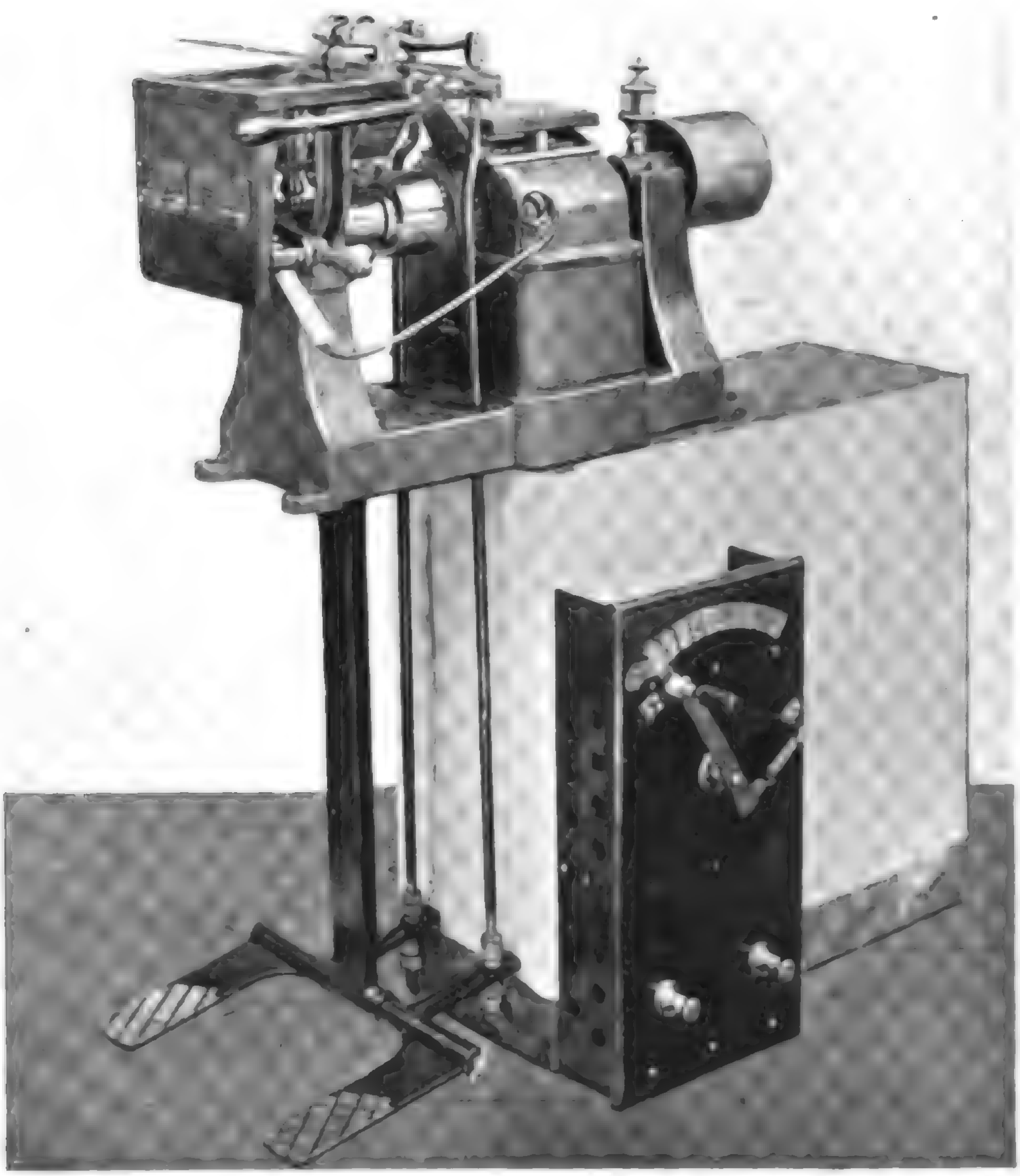


FIG. 2. ELECTRIC WELDER FOR GENERAL WORK.

current is furnished, without the intervention of a transformer, by the small belt-driven dynamo which forms part of the machine. The pedal serves to grip the clamps, and the small handle to compress the weld after welding-heat is reached. The heat can be so nicely regulated that the most difficult welds can be made with the certainty of a good result.

An interesting collateral use of welding apparatus may be found in the application of heavy currents for the local annealing of hardened steel plates, such as are used for safes and the armor of ironclads. The latter case presents enormous difficulties, since the plates are as

FIG. 3. ELECTRIC ANNEALING APPARATUS, CHERBOURG, FRANCE.

hard as nickel and tempering can make them, and so tough that, even when annealed, they are none too easy to drill. In addition, the plates may be a foot or more in thickness. In default of local annealing, holes have to be drilled before the huge plate is hardened, which often causes cracking during the hardening process, and is inconvenient; or the places where holes have to be drilled must be protected from hardening, which is exceedingly troublesome. In the electric annealing process a welding transformer with small copper terminals is used. Placing these terminals on the hardened plate, and passing a heavy current,—10,000 amperes or so,—the plate is locally annealed, so that it can be drilled. The copper terminals are hollow, and a

stream of water is kept running through them to prevent their destruction by the enormous current density used,—say 40,000 amperes per square inch. Such an annealing transformer, with the necessary regulating apparatus, is shown at work in Fig. 3. The scene is in Cherbourg, France, and the extraordinary grain of the tempered armor plate is beautifully shown in the photograph.

It is tolerably evident from the foregoing that electric welding and its kindred processes are rather special than general in their application; but they have, nevertheless, a wide field in constructive metal working. In many large shops a small universal welder, with a good variety of clamps, would find use many times a day, while, if much special work has to be done, the advantage is increased. Aside from this ordinary process, probably the greatest gain lies in the direction of the Bernardos process and its modifications, specially applicable to working sheets of irregular form.

Most curious and interesting are the possibilities of X-ray work in metal-working establishments. One is far from suggesting the establishment of an X-ray outfit in every machine shop, but the process has its uses. The rays had hardly been introduced to the public in earnest before they saved several hundred dollars for a large electric manufacturing concern. It happened in this wise. Nearly a thousand pieces of small apparatus were ready to ship, when it was discovered that, although carefully made and permanently enclosed in their wooden cases, some of the interior connections were bad, the wires having slipped out of place. To take apart the cases, inspect the interior, and assemble again would have cost no small amount; so an X-ray set was put to work, whereupon the interior connections became plainly visible in the fluoroscope. Thus the whole lot was rapidly inspected, and the faulty ones were set aside for repair.

More recently, as X-ray apparatus has been brought into more practical shape, it has been proposed to use it in inspecting metals for faults and blow-holes. Even steel armor plate several inches in thickness can be penetated by the rays, by a very long exposure, sufficiently to show at least all important flaws in the resulting photograph. Moreover, a similar method may prove effective in the minute examination ot the texture of metals supplementing present means of research. Sheets perhaps up to an inch in thickness we may reasonably expect to examine successfully with the fluoroscope. Whether the inspection is by photography or by the eye, as just indicated, the flaws are apparent by the increased translucency (if we may use the word) of the metal. Fig. 4 gives a diagram of the photographic method of examination. From our present standpoint it seems of rather limited applicability, but it certainly gets at the facts in the case, and improvements in

apparatus and methods of getting X-rays, concerning which our knowledge is pitiably limited considering the vast amount of research expended, may at any time raise it to the rank of a method of general utility.

In this work of inspection of masses of metal, electricity can be made to play a most important part. Of course, surface flaws can be detected by the eye, and gross interior flaws by the educated ear and the ordinary tapping process. Both these fail in the detection of minor, yet serious, flaws, and in discovering that lack of homogeneity that may lead to grave results. Take, for example, a great steel shaft. Even if there are no flaws discoverable by ordinary methods, there still may be interior cavities, or even local differences of texture, sufficient to cause a terrible accident.

Such a shaft, however, can, without much difficulty, be inspected electro-magnetically so as to detect and locate even a mere hard spot in the interior, not to say more considerable faults. There are several ways of doing this, but the principle is about as follows. If a round steel or iron bar is surrounded at one end by a coil of wire through which a strong current is passed, the bar is of course magnetized, and the distribution of the magnetic field along the bar follows certain well-defined laws, while it is symmetrical around the bar. Wherever, now, a flaw exists or a part of the bar is even slightly harder or softer than the rest, the distribution of the magnetic field around and along the bar is changed, and this change can be readily detected. Fig. 5 shows the way in which such a field is investigated in the laboratory. Here c c′ is a long iron bar, B is a magnetizing coil near one end, b a small exploring coil slid along the bar, and a a′ are two stops to limit the motion of b. The current induced by suddenly moving b across the lines of magnetic force that issue from the rod between the stops is then noted on a galvanometer. By a similar arrangement the writer has been able to detect so small a local change of physical condition in a long bar as was produced by pounding it at a certain point with a wooden mallet.

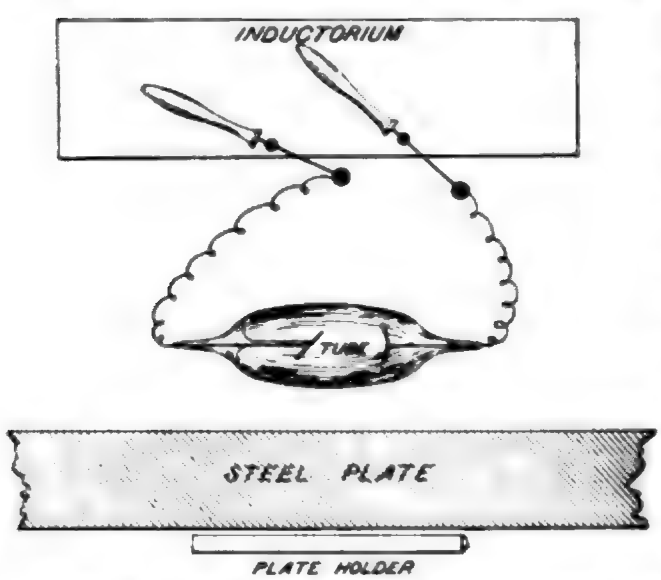


FIG. 4. X-RAY EXAMINATION OF METALS.

Under such a test not only flaws, but points of undue strain, would be plainly indicated, since the magnetic properties of iron are a most sensitive index of variations in physical condition. With proper apparatus even a mass like the shaft of an Atlantic liner could be inspected in the shop quite easily and expeditiously.

Finally comes the electric furnace with all its possibilities in the treatment of refractory materials. It has already given us one new material of great practical value, carborundum, and by means of it we are likely to add considerably to the list of alloys valuable in the mechanic arts. We have by no means come to the end of improvements in material; in fact, there is much to learn regarding even so common a material as steel. The electric furnace putting under control the highest known artificial temperature makes it easy to treat on a commercial scale the most infusible metals and to reduce the most refractory compounds. The opening of a new region of temperature means the acquisition of new and important chemical reactions, and raising old ones to the rank of commercial processes. Out of about fifty metallic elements only a beggarly dozen are used to any extent in the arts; the others are too rare, or too difficult to reduce in quantity, to

FIG. 5. ELECTRIC EXAMINATION OF SHAFTING.

be of any present importance. There is a great field to be explored, —the same one that has given us carborundum and cheap aluminum,— and, while we may find no new process for the every-day work of the shop, there is an excellent chance for finding new material for the workman, which is of still greater importance. Fancy the result of doing for aluminum what carbon does for iron, or for iron what antimony does in type-metal!

Reviewing now the utility of electrical energy in the work-shop, we find that, of the three functions noted,—*viz.*, saving in power, saving in labor, and saving in virtue of a new process,—the first-named affords the greatest opportunity for immediate economy. It can be utilized without any radical innovations in methods of work, and brings immediate returns. The method of applying the apparatus is straightforward and governed by fairly-well-defined laws.

The introduction of electric labor-saving devices is a matter of ingenious application rather than of well-defined system. The chance for saving is great,—perhaps greater than in the saving of power,—but

the apparatus is mostly specialized, and the greatest economy is attained in special departments of work. Sometimes no important saving can be made, while again there is every chance for good returns. Many of the most useful applications are to work quite outside of ordinary machine-shop practice.

The introduction of new methods due to the employment of electrical energy is a most promising field of wide and varied value. So far as metal-working is concerned, development has been so far along but a few lines, many of the most important improvements having been in collateral lines—electro-metallurgy, and various branches of the manufacturing arts. Some of the applications have been brilliantly successful, as in the adaptation of electric welding to the manufacture of projectiles and other special articles. Others have made but dubious successes. The prizes are great, however, for a new process may mean, not only the cheapening of a product, but the accomplishment of a task hitherto commercially impossible. The saving of power demands the close attention of the engineer; the saving of labor, the *finesse* of the skilled manufacturer; the achievement of a new process, the rare talent of the inventor. The three combined are likely to work a revolution in industrial operations that will be a credit to the on-coming twentieth century.

EARLY STEAMBOATS ON WESTERN AMERICAN RIVERS.

By Cons. D. Millar.

THE Ohio river, from Pittsburg to its mouth in the Mississippi, near Cairo, Ill., has a length of about one thousand miles. Its total drainage area is about two hundred and ten thousand square miles. The total population of the cities and towns situated immediately upon the banks of the Ohio and its principal tributaries is about two millions. Hence the importance of the stream as a highway of commerce is great.

Geologically the formations along the upper Ohio valley belong generally to the sub-carboniferous groups, but at various points on the upper river, and as low down as Brandenburg, Ky., 640 miles below Pittsburg, are found the Niagara limestones—oil- and gas-bearing rocks. The diversity of mineral resources has of itself brought great wealth to the valley, and has proved a great incentive to the establishing of manufacturing enterprises; these in turn have brought population. The coal traffic on this river is greater than all the traffic on the Mississippi, excepting that which it receives from the Ohio.

The first work to improve the navigation of the Ohio was done in 1825. At that time the river was obstructed by snags, rocks, gravel, and sand bars throughout its entire length. The government has been liberal in its appropriation of money for the improvement of the Ohio and its tributaries, as well as in placing beacon lights to assist in navigation during the night.

Safe ice harbors have been formed at various points along the river to give protection for shipping in time of danger from ice.

During 1896 more than eight million tons of freight and more than five hundred thousand passengers were carried by boats. The freight consisted of coal, iron, manufactured products, and general merchandise, and its value exceeded $250,000,000.

The capital invested in boats is, approximately, $8,500,000. The total amount expended on the improvement of the Ohio for the last seventy years is not more than 2½ per cent. of the value of the freight carried on the river in a single year.

The Davis island movable dam, near Pittsburg, has been in successful operation since 1885. A number of other dams are now being constructed. In general terms, the object of the work being done, and of that projected, is to secure, as far as may be, uninterrupted navi-

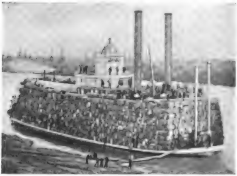
THE NEW ORLEANS LEVEE IN THE PALMY DAYS OF WESTERN RIVER TRAFFIC.

gation with a minimum low-water channel depth of six feet, which is sustained in the harbor at Pittsburg by the Davis island dam during the lowest water.

The annual shipments down the Ohio by steamer average more than 7,000,000 tons, and the number of passengers averages more than 1,600,000. Coal shipments are not included in this estimate. Shipments of logs, lumber, and railroad ties towed and rafted amount to 1,000,000 tons. Of corn, oats, hay, apples, potatoes, cabbages, cider, tan bark, hoop poles, lime, etc., sent by flat-boats, there are 50,000 tons. Of glass and stone ware, dry goods, groceries, oil, hides, pelts, oil barrels, scrap iron, old rope, etc., sent by trading boats, there are 15,000 tons.

A GROUP OF "OLD TIMERS" AT THE NEW ORLEANS LEVEE.

At the close of the Revolutionary war, the settlement of the Ohio valley began, and with it came the merchant emigrant. His boat was large and well protected from invasion, but otherwise very like the former and still-existing craft, known as the "Kentucky flatboat," built for a cargo of merchandise as well as to carry the passengers who, for a small price paid to the master, were allowed to work their way at the oars, and to fight the Indians if any attack was made. Girty, the notorious white renegade, who led the Indians in their onslaughts,



A COTTON TRIP ON THE MISSISSIPPI RIVER.

being a white and of fluent speech, often induced the unwary boatmen ashore, where they were attacked by his hidden associates.

In June, 1787, James Wilkinson fitted out a small flat-boat, loaded it principally with tobacco, and descended the Ohio and Mississippi to New Orleans, closing out his cargo with good profit. While there, he secured the following peculiar contract:

"This is to certify that James Wilkinson is granted permission to import on his own account, to New Orleans, free of duty, all the productions of Kentucky. He is to furnish tobacco to the king of Spain at $9.50 per cwt. (Signed) "MIRO, Gov. of Spanish Provinces."

This was the first shipment of record, of Kentucky production, but it was followed by increasing annual shipments, until, by the beginning of this century, the trade had grown to mammoth proportions. Then followed the return-cargo system of freighting, and the "Kentucky flat-boats" dropped out of use, except for down-stream transportation.

About that period the Ohio and Mississippi rivers were infested with multitudes of banditti, freebooters, and cutthroats, who, although of white complexion, were no better than the Indians. Many of the leaders of these bands had been early in command of boats with valuable cargoes, and, when so intrusted, never betrayed their trust; but they became debauched by the rough, wild life, and the facilities for evading the law. Living on the lines which divided different civil jurisdictions, they could pass quickly from one to the other and be held amenable to none. From Louisville to the mouth there were few settlements, and it was in this wild country that the depredations upon commerce were committed, Cave-in-Rock and Cash River being the most notorious spots.

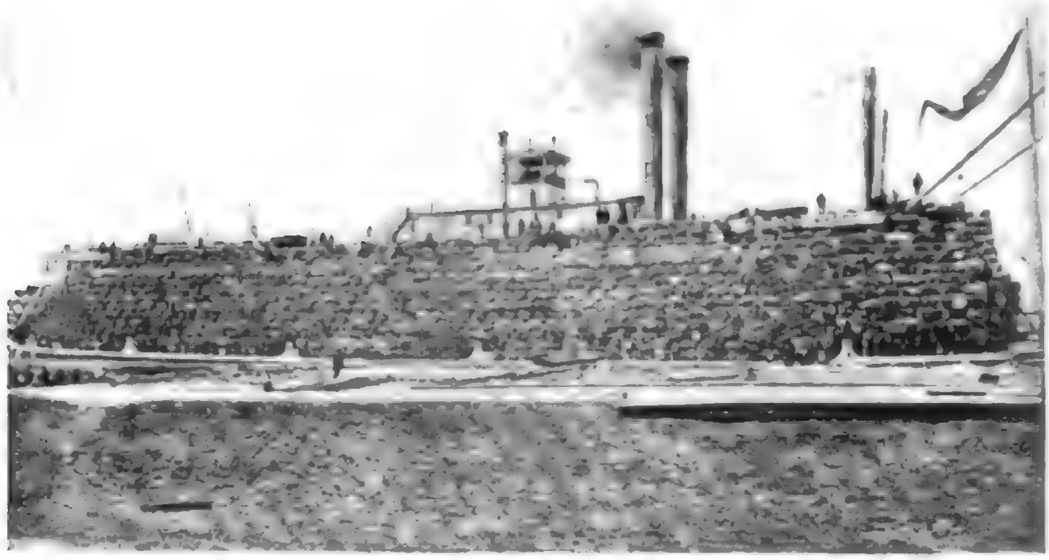
The bargemen or voyagers seem to have been a distinct class; as Audubon wrote, their "fearlessness of character, recklessness of habits, and laxity of morals rendered them a marked people."

The keel boats carried from thirty to seventy-five tons, employed from ten to fifty men, and were provided with a mast, square sail, and coils of cordage, called "cordelles." When the sail was useless, the cordelles were laid; yawls went ahead a thousand feet, where the end of the cordelle would be tied to a tree, and, with the other end upon the barge, all hands would lay hold and pull. By the time the first line had all been "hauled aboard," another had been laid, and the crew were at work again. This work continued from daylight to dark over a space of nearly 1,600 miles, if the trip was to Louisville, and 600 miles further, if to Pittsburg. The down-stream trips were resting-spells for the men, as the current then carried the boats, laden with tobacco, lead, pork, flour, whisky, and other produce. The return trips were another matter. To make the trip from New Orleans to Louisville in three months was considered quick travel.

The passenger packets (carrying limited quantities of merchandise) were propelled by oars, not by cordelles; so also were the barges on the lower river, which carried only merchandise cargoes, and kept pretty well away from the shore to avoid Indian attacks.

Thus the navigation of the Ohio was maintained for twenty years before the use of steam for river navigation.

The New Orleans was the first steam vessel west of the Alleghenies, and was built by Fulton. It was 138 feet long, and of about 300 tons'

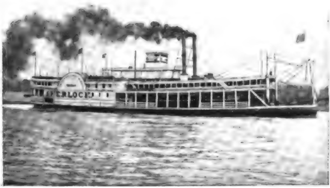


THE COTTON CARRIER HENRY FRANK WITH 9226 BALES OF COTTON AND 250 TONS OF SUNDRIES.

She arrived at New Orleans from Memphis April 2, 1881.

capacity. The people of Pittsburg lined the banks and waved adieus as the steamer weighed anchor, and she soon was out of sight, having shown a speed of ten to twelve miles per hour. On the second night after leaving Pittsburg, she cast anchor opposite Cincinnati. She received a joyous welcome, but all believed, and many declared to A. J. Roosevelt, one of her owners; "Your boat may go down stream, but never can come back ; the idea is absurd." She took on a supply of wood, and, after a short stay, left for Louisville, arriving there on the night of the fourth day after leaving Pittsburg. A public dinner was tendered Roosevelt at Louisville. As the river was too low to permit a passage over the Falls, she lay at anchor opposite the town. Roosevelt, not to be outdone in hospitality, invited his hosts to dine upon the steamer. While the feast was at its height, sudden rumblings were heard, and a perceptible motion became apparent, when all rushed to the guards, believing the steamer had broken her anchor and would be carried over the Falls to certain destruction. They soon found that, instead of going on to the Falls, they were making good headway up stream. After a short trip, they returned to Louisville, a surprised and delighted party. The steamer was built for the trade between New Orleans and Natchez, but, awaiting the expected rise, Roosevelt went to Cincinnati and returned, thus convincing the most incredulous of the vessel's power to stem the current of

MEMPHIS AND ARKANSAS CITY PACKET KATE ADAMS.



THE CINCINNATI AND NEW ORLEANS PACKET THOMAS SHERLOCK.
Totally wrecked in the winter of 1890 by collision with a pier of the C. & O. R. R. bridge at Cincinnati.

the river. The river had risen, and she descended the Falls in safety. While she was going down the river, a large canoe, fully manned, came out of the woods abreast of the steamboat, and paddled after her.

CINCINNATI AND NEW ORLEANS PACKET CHAS. MORGAN.

THE ROBERT E. LEE.

There was a race, but the steam had the greater endurance, and the Indians soon gave up the chase. At New Madrid, Mo., a great portion of which town had just been engulfed by an earthquake, terror-stricken people begged to be taken on board, while others fled from fear. The earthquake had so changed the channel of the river that the pilots made the trip more by luck than knowledge, for the river was full of shoals, snags, and sawyers. The New Orleans had a stern wheel and two masts,—for even Fulton thought sails absolutely indispensable,—and one engine. She continued her packet trips between Natchez and New Orleans until July, 1814, when she struck a snag near Baton Rouge and was wrecked. Her average speed was about three miles an hour up stream. She made several trips to Natchez before the merchants would assume the risk of shipping freight on her, preferring the old slow barges or keel boats. In 1814, more than two years after the building of the New Orleans, the "Vesuvius" was built at Pittsburg. She went to New Orleans in the spring, left New Orleans in July for Louisville, grounded on a sand bar near Helena, remained high and dry for five months, and, when released by the tide in December, returned to New Orleans. Her record offered no encouragement to ship-building.

In 1814 the steamer Enterprise was built at Brownsville, Pa., made two trips to Louisville, and returned to Pittsburg. In December, 1814, she was laden with ordnance stores at Pittsburg for Jackson's army. Gen. Jackson pressed her into the United States service for carrying men, stores, ammunition, &c., to the seat of war. She was released when peace was declared, and, loading for Pittsburg, made the voyage in fifty-four days,—considered a quick trip.

In 1816 a steamer—the first double-decker—was built at Wheeling by Capt. H. M. Shreve. Shreve used French's engines, but placed them in a horizontal position, and gave the vibration to the pitman. He added his great invention, the cam cut-off, and put flues in his boilers, by which three-fifths of the fuel was saved. He named the boat Washington. Leaving Louisville March 12, 1817, she went to New Orleans, discharged and reloaded, and, returning, reached the foot of the Falls in forty-one days. The ascending voyage was made in twenty-five days, including stoppages. This trip seemed to revolutionize the feeling of the public, and created as much excitement and exultation as Jackson's Battle of New Orleans. The citizens of Louisville gave a public dinner to Shreve, at which he predicted that the time would come when the trip—New Orleans to Louisville—would be made in sixteen days. When the Washington arrived at New Orleans, she was seized by order of Fulton and Livingston, who claimed the exclusive navigation of the river to the

U. S. BEACON-LIGHT TENDER LILY, AT COX'S RIFFLE LIGHT, OHIO.

Louisiana line, having been granted that right by the Louisiana legislature. She was bonded, and the case was taken to the United States supreme court, where Chief Justice Marshall decided "that the waters of the United States were free to be navigated by all citizens, and no State could grant exclusive privileges to a company or individual."

Several boats of queer design were built in the years following, among them the steamer Bazabeel Wells, the greatest curiosity of the age. She was built in 1819, with an engine from a flour mill at Steubenville, boiler from another mill at Pittsburg, and a chimney of brick. The first landing she made knocked down her chimney, whereupon she was provided with a sheet-iron smoke-stack.

In twenty years the genius of the United States made such strides in navigation and transportation that the water ways became almost exclusively the routes of travel. About this time the great system of national highways or turnpikes was introduced and rapidly extended, but the river transit had grown to be so restful, agreeable, and comfortable, and withal so speedy, that everybody who traveled went by steamboat.

From this time until the early fifties steamboats were built in great numbers; the improvement was continuous, and many of the finest steamers ever constructed were built and placed in commission. The decade of 1850–60 was the golden age for steamboats. Daily lines of fast mail steamers were inaugurated. Prominent among these were

the Pittsburg & Cincinnati line, in connection with the Pennsylvania Railroad, which had just then reached Pittsburg from the east, and the Wheeling & Louisville Union Line, which connected with, and exchanged freight and passengers with, the Baltimore & Ohio Railroad at Wheeling. The rivalry was great, and excitement ran high. Every man, woman, or child along the river had his or her favorite steamer.

The movements of the boats were marked with great ceremony; the crew were full of superstition, and the commanders a law to themselves, and masters of their craft from the pilot-house to the keel.

In the days of the gold excitement in California Missouri river pilots received five hundred dollars a month, work or play. They were all under pay to keep them from standing a watch on outside boats. Similar wages were paid in the New Orleans and Red river trade in the fifties. Now pilots are paid from seventy-five to one hundred dollars a month in the Cincinnati, Memphis, and New Orleans trades.

In the early fifties the Pittsburg & Cincinnati Packet Line consisted of a fleet of fast side-wheel steamers, finely modeled, with big power, but of limited freight-capacity, comprising the Buckeye State, Allegheny, Brilliant, Monongahela, Crystal Palace, Pennsylvania, and Pittsburg; while the opposing boats, known as the "Wheeling &

THE SULTANA AT THE WHARF AT HELENA, ARKANSAS.

The photograph was taken at 10 a. m. on a spring day in 1865. At 2 a. m. the next day the boilers exploded and 1700 persons were killed, chiefly exchanged Federal prisoners on their way home. This was the greatest loss of life recorded in any western American river accident.

Louisville Union," consisted of similar crafts, named the Alvin Adams, David White, Thos. Swan, Baltimore, Falls City, Virginia, and City of Wheeling. To illustrate, we give the dimensions of several of these fast clippers—all side-wheelers.

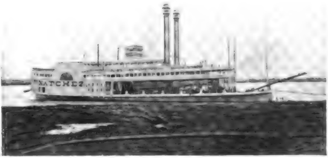
The Buckeye State, built at Pittsburg: length, 285 feet; beam, 30 feet; floor, 28 feet; depth of hold, 6½ feet; capacity, 548 tons; five double-flue 42-inch boilers, 30 feet long; 30-inch cylinders; stroke, 8 feet. The fastest trip from Cincinnati to Pittsburg credited to the Pittsburg line in 1851 was made by the Buckeye State,—490 miles in 40 hours.

The Pittsburg, built at Shousetown, Pa., in 1851: length, 295 feet; beam, 30 feet; floor, 29 feet; hold, 6½ feet; capacity, 650 tons; five double-flue, 42-inch boilers, 30 feet long; 31½-inch cylinders; stroke, 8 feet. Value, $30,000.

The Alvin Adams, built at McKeesport, Pa., in 1853: length, 283 feet; beam, 35½ feet; floor, 33 feet; hold, 6⅔ feet; capacity, 750 tons; six double-flue, 42-inch boilers, 28 feet long; 29½-inch cylinders; stroke, 9 feet. Value, $50,500.

The great low-pressure Jacob Strader, of the Cincinnati & Louisville Mail Line, built at Cincinnati in 1853: length, 332 feet; beam, 37 feet; floor, 32 feet; hold, 7½ feet; two 16-flue boilers, 11 feet

THE R. R. SPRINGER LYING AT THE CINCINNATI WHARF.



THE MISSISSIPPI RIVER STEAMER NATCHEZ.

Grounded at Lake Providence, in the Lower Mississippi; the steamer was lost but her outfit was saved. The present Natchez is a stern-wheel boat.

in diameter and 38 feet long; two puppet-valve engines, 5 feet in diameter; stroke, 10 feet. Value, $120,000. Her boilers, not working well in the muddy water of the Ohio river, were removed, and the old-fashioned double-flue boilers were put in their place. The Strader has the fastest time on record from Louisville to Madison,—43 miles in 3 hours and 12 minutes. The Telegraph, of the same line, having made the fastest time from Louisville to Cincinnati the same year,—9 hours and 52 minutes,—the Strader was not permitted to beat it, though she could have done so easily. The only steamer that claims to have beaten the Telegraph's time from Louisville to Cincinnati is the new City of Louisville, of the same company, which made the run from port to port in 1896 in 9 hours and 40 minutes.

The fastest trips from New Orleans to Cincinnati—1,513 miles—have been made by the following boats, all side-wheel: 1843, Duke of Orleans, 5 days, 18 hours; 1877, Chas. Morgan, 6 days, 11 hours, making 42 landings and losing 3½ hours passing through the Louisville canal; 1877, Thompson Dean, 6 days, 19 hours, losing 14 hours in the canal and 17 hours at way-landings; 1881, R. R. Springer, 5 days, 12 hours, 45 minutes, running time; 1881, Will S. Hays, 6 days, 17 hours, 10 minutes, port to port, having made 51 landings, and met with other delays.

The Dean and Hays had 30-inch cylinders, with a stroke of 10 feet. The Duke of Orleans, like all boats that passed through the old short Louisville canal, was only 172 feet long.

With the present enlarged canal, the boats now in use are longer and of lighter draft, with more than double the capacity, enabling the Upper Ohio to compete with the Lower Ohio and Mississippi steamers.

For general freight-business, economy, passenger-comfort, and speed, the stern-wheel is fast taking the place of the more expensive side-wheel steamer on the Ohio and Mississippi and their tributaries. They make the same time in all packet trades, and, in comparison with the old side-wheel packets, carry twice the cargo with less power. In the New Orleans and Lower Coast trades, the stern-wheel steamers, Natchez and T. P. Leathers, are a great success. The same may be recorded of the packet lines on the Upper and Lower Ohio, the Cincinnati and New Orleans, and the St. Louis and New Orleans trades. The Anchor Line has recently built the stern-wheel Bluff City for the St. Louis and New Orleans trade, and she has proved a great success. A new and magnificent freight and passenger steamer, the Queen City, will soon be ready, at Cincinnati, for the Cincinnati and Pittsburg trade. She will make weekly round trips, carrying as many people, and more than twice as much cargo, as were carried by the celebrated side-wheelers in the fifties. Most of the timber used in the construction of the Queen City is Oregon fir, lighter than oak, but little heavier than pine, and more durable. Her length is 235 feet; beam, 44 feet; depth of hold, 6½ feet; capacity, 1,400 tons; four boilers, 47 inches in diameter and 26 feet long, containing six flues each, allowing a steam pressure of 166 pounds; cylinders, 24 inches in diameter; stroke, 8 feet, equal to 2,000 h. p. She will have all steam and electrical improvements, automatic steering apparatus, and steam and water works pumps, carrying a constant supply of water to all parts of the boat. The state-room panels will be finished in mahogany, and the skylight ceiling of the cabin with pressed steel in high-relief work beautifully decorated in blended colors. She will be brilliantly lighted throughout with incandescent lights, and a beveled-edge French plate mirror will be placed in each state-room door. Her carrying-capacity will be equal to that of three average freight trains, yet she will not draw more than 26 inches of water. She is adapted to any trade along the Ohio or Mississippi rivers.

The famed City of Louisville,—noted as the "Kentucky Greyhound,"—built at Jeffersonville, Indiana, by Howard, for the Louisville & Cincinnati Packet Line, is a side-wheeler, and very fast. Commodore F. A. Laidley, general manager of the line, kindly furn-

ishes the following official memorandum of this steamer: capacity, 1,142 tons; length, 301 feet; beam, 42 feet; depth of hold, 7 feet; built, 1894; eight boilers, 26 feet long and 42 inches in diameter, containing two flues 15 inches in diameter; cylinders 30 inches in diameter; stroke, 10 feet; wheels, 36 feet in diameter; time, down stream, Cincinnati to Louisville, 5 hours, 58 minutes; up stream, 9 hours and 40 minutes, fastest on record, made April 5, 1896.

The rapid decline in steam boating on the western American rivers is attributed to the rapid increase in railroads and the diminution of the water-supply. The government has awakened to the fact that the waterways must be cherished, and the navigation of prominent streams made continuous and permanent. This is now being done by the construction of the chanoine dam, which can be raised or lowered in a few hours, thus not interfering with navigation when nature supplies the volume of water, but furnishing a guarantee of steamboat transit, except when ice prevails. Last year congress appropriated more than $11,000,000 for the maintainance and construction of these betterments. The bill was vetoed by the president, but passed over his head. This improvement established, the Ohio valley must become the coal-producing center of the world. England's coal-supply is limited. The almost limitless coal fields of Pennsylvania, West Virginia, Ohio, and Kentucky, being adapted for rehandling and for foreign shipment, can supply the demands of the world for ages.

Under the old *régime*, 20 men handled a pair of boats, containing 20,000 bushels of coal, to Cincinnati from Pittsburg, time averaging 10 days. The cost of boatman's labor alone was about three cents a bushel. To-day the same number of men, with a steamer, will bring to the Cincinnati market 200,000 bushels at a cost of one cent per bushel for boatmen's labor. The steamer Joseph B. Williams, from Louisville, recently arrived at New Orleans with 1,500,000 bushels of Pittsburg coal. To transport this by rail would cost $3.50 per ton; river transportation costs 50 cents per ton. With the building of the canal from Pittsburg to the Lakes, the locking and damming of the Ohio river, and the construction of the Nicaragua canal, Pittsburg coal can be sold in San Francisco at $4 to $5 per ton, where other and inferior coal is now selling at $7 to $8. American coal could be sold at Callao on the west coast of South America at $5 per ton, where it now commands $15. In Valparaiso, where other nations control the coal trade, United States coal could be furnished at $5 to $6, while now the price varies from $12 to $13.

The editor expresses thanks to Mr. C. H. Hugger, of Owensboro, Ky., for the loan of the photographs from which the illustrations accompanying this paper were made.

THE CARE AND OVERSIGHT OF THE POWER PLANT.

By T. Carpenter Smith.

IN looking over the list of modern inventions, one is struck by the continuously-increasing speed with which developments in the mechanic arts are commercially adopted. In nothing is this better shown than in the now almost immediate acceptance by the world at large of methods and applications which a few years ago would have met with strong opposition, critical examination, and finally a grudging acquiescence. Comparing the relative time in which the general adoption of the electric telegraph, the telephone, the electric light, and electric power were brought about, we see that the number of months required for the development and adoption of the telephone was smaller than the number of years required for the development and adoption of the telegraph. Almost as soon as the electric light was heard of, there was talk of the immense strides which it was making. And electric power had hardly been suggested before it became an accomplished fact.

For years uncertainty of the electric light was looked upon as natural and to be expected; the most annoying failures were met with a good-natured shrug. The trite remark that "electricity is only in its infancy" was a sufficient excuse for these annoyances; but, with the revolution wrought by the electric railroad in city transit, there has come a complete change in the attitude of the public. When the power shuts down, the sentiment is no longer that "blessings brighten as they take their flight." Public dissatisfaction finds an expression in the query: "What is the use of granting monopolies to those who don't know how to treat the public decently."

Comparatively few persons realize the care, patience, and technical skill required to properly handle the latest developments of electric power. Nearly every other business has some one dominant condition, but the power station is controlled by several very diverse ones. To understand and successfully direct any one of a large selection of small manufacturing industries is generally thought sufficient for one man, yet the power-station manager must know and satisfy the needs of all. Time will develop a sufficient supply of men fitted for this particular calling. Meanwhile there are many men who, having but moderate experience in one or more of these lines, can only try to do their best. It is for such men that consideration is particularly needed.

The duties of a general manager or general superintendent lie in two directions; first, toward superior authority, and, second, to the work in charge. Dealing with superior authority is purely a question of individual tact. It is intensely disagreeable and annoying to receive orders or make explanations to a board of directors or executive committee consisting of men who, perhaps, are totally ignorant of the business, its machinery, and its difficulties; yet it must not be forgotten that these men have responsibilities, and must account to the stockholders for the use or misuse of their property. The superintendent should, therefore, cultivate the art of so explaining technical matters that those who know nothing of technicalities may understand; above all, he must never avoid questioning, or attempt to conceal facts. It is not wise to offer too much information as to details, especially where details may entail expense, but, if there is a manifest desire for further information, a straight and reliable account of the matter is the wiser course, since business men, as a rule, will far more readily forgive mistakes than concealment or deceit. Many a man's hair has been made grey before its time in steering a judicious course between this Scylla and this Charybdis.

It has always seemed to me that the most important detail of the power station is, without question, the men employed. Many of the questions or conditions governing the economical performance of the machinery have been settled definitely in the shops of the manufacturer, but the manner in which the machinery is handled, while the most uncertain element, is the element which affects general results in the greatest degree. Until we have trained men who are competent to do any part of the work about a power plant, it will be necessary to have in the station different gangs,—one set for boilers, another for engines, perhaps a third for dynamos, and so on.

When a new industry increases with marvelous rapidity, there is always a lack of men to take the responsible positions, more especially when the industry, as in this instance, deals with principles that are commonly but little understood. The difficulty created by this want of trained men is intensified by the rush into the trade of two classes, each with peculiar limitations. One class consists of men who know how to do the manual work themselves, without the ability to put their knowledge into words for the benefit and instruction of others, and who know little of the more scientific side of the art; the second class includes men who are fully acquainted with underlying principles and can clothe their ideas in suitable words, but who have no knowledge of the actual machinery used, or the conditions which may arise under which it may have to be worked. This has led to antagonistic feeling between the so-called practical man and the theorist, each

underrating the importance of the other, and magnifying the proportion which his share of the work bears to the whole.

In selecting men for the more important subordinate positions, the best workman may be found to make a very bad foreman, and *vice versa*. A man may be a first-class director of work who has himself very little individual skill; in fact, a good mechanic who has executive ability is decidedly a *rara avis*. The average good workman never recognizes this fact, and often feels aggrieved at the promotion of one who, as a workman, is his inferior.

The first principle to be thoroughly drilled into all hands, from superintendent to oiler, is loyalty to the interests of the company. No personal antagonism or aim can be allowed for one moment to interfere with this, and any conduct which tends in this direction must be made the unpardonable sin.

Only second in importance is the principle that a power station is a public servant, and that even the appearance of wishing to dictate to the community must be avoided. There is no customer whose trade is so valuable as that of the general public, and there is no customer who has to be as carefully and anxiously studied, and who is more influenced by feeling and sentiment. There are the two classes of dissatisfied people,—those who are honestly dissatisfied because they cannot see the purpose of many of the rules necessary in dealing with the conditions of a new business, and those who always try to take advantage of any contract. It sometimes requires the patience of Job to give a good-tempered explanation even to a reasonable man; the impossibility of pleasing the dishonest is additional cause for keeping all the friends one can.

One factor in the management of a power plant which has seldom been sufficiently recognized is the tendency of men to take good care of machinery which they personally like, and to neglect or abuse that against which they have some prejudice. This tendency is dangerous. Those in authority cannot guard too carefully against even a suspicion that they have a prejudice for or against any machine. It is one of the few pleasures in the life of a station superintendent to find a man governed by the principle that his duty is to get best possible results out of the machinery he attends, who wastes no time in grumbling or in explaining how much more efficient some other kind is, and who prides himself that he is getting better returns out of that particular machinery than any one else.

The average workman is, in most cases, opposed to the use of a plant which requires him to find out anything for himself. No amount of information given in circulars or catalogues is one-tenth as effective as an object-lesson on the thing itself by some one familiar with it,

who can show him the easiest and quickest method of adjustment or operation. One has to be patient with this, since it is as much a matter of training and practice to acquire information from reading, as from a drawing or diagram. The average machine-tender has not usually the opportunity for such training.

It is most difficult to enforce in a large body of men perfectly even-handed discipline, and yet there is nothing that is more absolutely required for good order. It seems proper to forgive some occasional lapse from good behavior in the man who is ordinarily better and more capable than his fellow-workmen, but to do so will certainly and quickly lead to jealousy, and that indefinable clannishness which forms the dry rot of a station force.

From highest to lowest there must be a well-marked grading ot authority, and the men must be shown that the object of this is not to prove one man more of a favorite or better than another, but simply to make it easy to settle responsibilities, since, in all cases of accident or emergency, the man highest in authority on the ground is the man to whom all must look for orders, and it must be known at once who this man is. This is not always an easy matter to arrange. It is governed largely by the circumstances of the station, and whether the men are in distinct departments or not; so that to determine where the duty or authority of one gang ends and that of another begins sometimes requires not a little careful study. I have heard of a housekeeper who, when quarrels arose between servants, would decide who was right or wrong by simply inquiring where the quarrel took place. If it occurred in the kitchen, the cook was in the right; if it occurred outside the kitchen, the house-maid was in the right. In a large electric-light station there was, at one time, a continual friction between the engine men and the dynamo men, taking the form of disputes as to who had authority to order the engines or dynamos started and stopped. The dynamo men would signal for a particular machine to be started up, knowing that the engine was not ready to run, and calling for that particular machine only in order to have ground for complaint. Again, the engine men in the middle of a run would suddenly shut down an engine, doing this when they knew that the dynamo men had no other machines ready to take the place of those thrown out. Both parties were good men, who had become a little wrong-headed, since each thought the other trenching on his neighbor's domain. After some cogitation, the matter was stopped by the superintendent, who laid down the law that the dynamo men had absolute authority to decide which dynamos should be started, and when. The engine men were always to have the engines ready for operation, and must never refuse to start them without good reason, for which they

would be held responsible. On the other hand, the engine men had the right, at any time when machines were running, to shut them down, first giving notice to the dynamo room, and stating what other engine was in condition to run. For this they were also to give good reason, while the dynamo men were expected to have the dynamos always in proper condition to run, to prevent useless delay. The natural result of this ruling was seen in a few days. Neither side could get the other into trouble, but both sides were very much on the alert not to be caught napping.

A careful log kept in each department is practically a necessity. One of the more easily-combatted difficulties encountered in enforcing this is the dislike of writing or figuring by men unaccustomed to it. This can be met by forms which are practically skeleton reports, requiring only the marking of a number or a few words in places designated. The fear that reports are in some way a comparative test of ability or diligence, and the unwillingness to submit to anything that looks like such a test, is in exact, but inverse, ratio to the caliber of the individual.

The introduction of recording meters of all kinds has very much simplified the question of records, but it has introduced another set of machines or instruments to be watched and calibrated; like safety valves, these meters are to be trusted only when regularly tested.

Passing from the human to the mechanical part of the plant, we begin naturally with the boilers. It is more in the boiler room, perhaps, than in any other part of the plant that money is made or lost, and mostly between the coal-pile and the stop valve. One constantly hears of the wonderfully-skilled engineer who saves his salary every year, but his opportunities for waste or economy are small beside those of the fireman. An engineer may examine and readjust a valve once a week to produce a trifling economy of steam, but the fireman practically makes an adjustment with every shovelful of coal he pitches; and, while we find the engines, dynamos, etc., all regulating automatically for changes of load, the cases where automatic regulation is applied to boilers are comparatively few. Engines can practically be shut down at any moment, and stand idle for an indefinite period without loss; but each time a boiler is thrown in or out of service there is waste of coal and labor in starting a fresh fire or drawing the old one.

Probably the most important item is the care regarding feed water. Water varies very much in different localities, and careful analysis is required to determine just what means must be used to counteract particularly injurious ingredients. After every precaution, and when the trouble has ceased, it may appear again in some entirely

unexpected way. An engineer who had been advised to use kerosene in boilers to prevent scale had great success with it for years, when suddenly his boilers began to scale badly; after months of patient and wearing investigation, he found that the difficulty was due to a gradual change of working pressure from one hundred to one hundred and fifteen pounds per square inch. The scale-making ingredients of this particular water at the heat due to the lower pressure would not bake hard, but would form a sludge with the oil and be easily blown out, but at a slightly higher temperature they would cake, and burn on to the tubes and headers, seriously interfering with the steaming of the boilers. Scale is a mild and open enemy, however, compared with pitting and corrosion. After all, no precautions can take the place of constant, systematic, and careful inspection, both internal and external, of each boiler in turn, at times when the boiler and its setting are cool enough for deliberate work.

The selection of fuel is no more of a problem in the power station than anywhere else, but the keeping of a supply on hand to guard against storms, strikes, or break-down is often a serious difficulty, particularly if the fuel called for by local conditions is of a kind which deteriorates by keeping or by exposure to weather, and is thus found unreliable when most wanted. As the final proof of a fuel is in the burning, it is sometimes necessary to arrange the fuel bins to hold a several days' supply, the fuel for use being always taken from the bottom, and the new put in at the top. In this way any poor fuel delivered is speedily found out,—not left to be discovered in time of distress. It is also well to have duplicate bins, using from No. 1 and delivering into No. 2 until No. 1 is emptied, and then making this last the delivery bin, and using out of No. 2 until empty; thus an accurate account can be kept of amounts of each shipment. In order to decide which is the best fuel, many things have to be considered besides first cost per ton. A smaller percentage of ash will sometimes make a higher-priced coal the cheaper. A careful hourly record should be kept of every pound of coal burned, and also of the output. In one station the firemen were repeatedly detected in "cooking" the records,—generally by entering less than the amount of fuel used under the idea that this was in some way a proof of their skill. It was a great puzzle to them that every time they did this they were immediately tripped up. They were not versed in the mysteries of "fuel per unit of output," which the manager worked out from the dynamo-room records, and so they would occasionally hand in reports showing efficiencies of more than one hundred per cent.

The many serious accidents from explosions of steam pipes suggests the use of a number of moderate-sized mains rather than one

or two very large ones. Among awkward accidents arising from want of foresight in design may be cited a case where a large valve in a steam main was shut down while some changes were made in pipe connections; when the time came to again start up the machines on the other side of this valve, it was found impossible to do so, owing to the pressure upon the valve itself. After applying force till it was feared that the valve might be broken by greater strain, a spare boiler had to be fired up in order to equalize the pressure on both sides of the valve, and allow of its being opened. The consequence of not having a by-pass around that particular valve had been overlooked, as it had originally been placed in the line for use only in case of extension.

Those who travel on an ocean steamer often wonder at the perfection of engines which run for days and weeks together without a stop. The marine engine, however, generally gets a pretty thorough examination and a partial overhauling at the end of every trip, and in an emergency can always be slowed down or stopped for a few minutes or hours; the engine in the power-house, however, must go on; slowing is as bad as a stop. Moreover, the time for repairs is generally very short; as many as possible spare interchangeable parts must be in readiness for needed substitution. No care is too great to give the engine while in operation.

There are fashions in engineering as well as in dress, and both move in cycles. The earlier electric-light stations generally consisted of small dynamos driven by independent high-speed engines; when the reaction set in against these on the score of economy, large engines driving through shafting and countershafting became popular. The increased trouble due to belting, and the evolution of larger and larger dynamos, turned design into the original channel of direct-belted units. With the power dynamo came the new difficulty of constant and heavy changes in load, until in many cases the duty of a power-house engine became a compound of steamship and rolling mill. The only radical cure lay in direct coupling, coming back after all to the direct-driven steam dynamo, the type installed in the first large station built,—that of the Edison Company in New York.

It used to be that the dynamos were the most delicate, the least understood, generally the most tricky, and the most exacting things in a station. This was very largely due to poor mechanical design and inferior work. Now the dynamos require as little attention as anything about the plant. To keep them clean and dry and their bearings oiled is all that is needed; when anything does go wrong, however, there is a deal of trouble. The worst troubles to deal with in a dynamo are those which occur deep in the interior; many can-

not be observed except when work is being done. The cultivation of a habit of close observation is, therefore, valuable, but it is difficult to impress upon men that things which in themselves are so slight as hardly to be seen may be the symptoms of a serious disorder.

A new danger has been introduced with the advent of electric transmission—the enormous amount of power which may be concentrated and let loose at a point apparently safe. In a boiler or engine room the presence of the machinery naturally gives the impression of a large force close at hand, but a copper rod, perfectly quiet and harmless-looking, gives no idea of the terrible destruction it can work.

It is the necessity for continuous service at all costs which brings the greatest strain upon the superintendent. Boilers may leak, valves may break, engines may knock, journals may heat, but the plant must go on. He has to consider, on the one hand, his duty to the public, who will suffer great inconvenience and loss if he shuts down, while, on the other hand, he may be endangering the lives of his employees. Of course, the matter is simplified if the failure of lights or power would endanger the public, since there can be no choice between risking the lives of many and helpless people and those of a few skilled men knowing their danger and able to take all possible precautions. Fortunately the dilemma occurs less and less frequently, its very seriousness having early attracted attention to it; but it comes often enough in one shape or another to form a decided factor in nervous strain.

ISOLATED PLANTS VERSUS CENTRAL STATIONS.

By Percival Robert Moses.

I.

THE attention of architects, engineers, and owners has been persistently directed to the question of comparative economy of a central-station supply for light and power and a similar supply from a private or so-called "isolated" plant in the building to be equipped. Articles pro and con have been published, containing conclusions based on theoretical conditions of amount of coal per horse power hour, cost of labor, water, oil, etc. I herewith present a comparison of the various items making up the total cost, as well as the final amounts, in installations with an isolated plant, and the corresponding items and totals in buildings obtaining their supply from central stations. The data have been obtained from the superintendents, engineers, and—in many cases—owners of the buildings, and I think they may be relied upon absolutely. The names are withheld for obvious reasons. In most cases they may be obtained by anyone wishing to investigate the results.

The comparisons instituted, to be of value, must relate to buildings similar in character, size, and relative situation. For convenience in tabulating and reference the installations have been divided into groups.

First: hotels, where a continuous service in most of the departments is required.

Second: apartments, where the service is continuous in some branches and intermittent in others.

Third: office-buildings (generally with ten-hour service).

Fourth: restaurants, clubs, etc., where the service is special in character, and each case must be individualized.

Fifth: buildings where the service is intermittent, with large maximum and small average load.

These groups do not include all the varieties of buildings constructed, but the classes are sufficiently broad and distinct to enable an engineer, architect, or owner to place his proposed building in one of them, and thus obtain an approximate estimate of the operating cost of an isolated plant under ordinary working conditions, and also of the cost of a similar supply from the central station.

In collating these statistics, many other points of interest were brought out, such as the relative advantage of the different sizes of coal, the economies resulting from the use of gas engines, storage batteries, exhaust steam, etc., which can only be briefly mentioned here. For example, it was proved that small sizes of coal give better results, weight for weight, than the larger sizes, if burned in suitable furnaces; that gas engines show large economies where the heating of the building is a small factor; and that storage batteries offer inducements where the service fluctuates largely, and in small installations where low-pressure steam for heating, dryers, etc., is required during the day.

In the class of buildings first considered—hotels—the service is severe and continuous. Steam is necessary in large quantities, irrespective of the requirements of a lighting plant, for heating, steam-mangles, drying-rooms, auxiliary engines, pumps, elevators, and kitchen. A trained engine-room staff is necessary, and usually consists of a chief engineer, two assistants, and firemen. In the larger hotels steam fitters, plumbers, and brick and tile layers are also employed. The addition of a lighting plant renders advisable the employment of a dynamo tender. The fuel cost is but slightly increased by the summer illuminating requirements. Therefore the central station service cannot profitably compete in economy with the isolated plant. That numerous hotels continue to use the central-station service is a remarkable example of the conservatism of capital; specious arguments, uncertainty of tenure, and lack of definite figures have prevented the proprietors from fully realizing the enormous amounts wasted.

Referring to Table I,—hotels 1 and 2 are old hotels, similar in size and in character of business. In the first, broken coal is employed, the boilers carrying 80 pounds, pressure, used directly on the radiators without any reducing valve. In addition to the heating, steam is supplied to kitchen, laundry, two elevators (one hydraulic high-speed and one steam freight), a slow-speed 20-h. p. laundry engine, and pumps. The cost of coal averages $24.10 per day. There are two engineers, two firemen, and one oiler, and the cost of fuel (coal), oil, water, and labor is $13,000 per year. The bills for lighting (gas on all floors, except the ground floor, which has electric lights) aggregate $11,000 per year. In the parallel case, No. 2, pea coal is used, at about two-thirds the price of the furnace coal. Ice is made on the premises, and refrigeration supplied to the store-rooms. The hotel is lighted night and day, and steam is furnished to laundry, kitchens, etc., and to one hydraulic combination freight and passenger elevator. The cost of fuel, labor, and repairs is less than $10,500 per year.

In these two buildings the labor employed is equal in cost and

TABLE I.—GROUP I.

No.	Charac-ter B'lding	Dimensions. H.	W	L.	Stories.	Total Lights.	Load Aver-age.	Fuel, cost per day	Est. c'st Light. Plant.	Eleva-tors. E.S. H	Plant Oper-ation, cost per year.	Ice Supply.	Aver-age Tons.	Labor. Eng	Fire men	Oth ers	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost.
1	Hotel	85	75	175	7	1300	200 (D) 700 (N)	24.10	—	1. 1.	(P) 13000.00 (L) 11000.00 (I) 2500.00	Company	2 (Est.)	2	2	1	24	Direct High Pressure	Broken	26500.00
2	Hotel	80	125	125	6	1500	300 (D) 1000 (N)	16.50	4500	1	10500.00	Machine	2	2	2	1	24	Exhaust.	Buck-wheat	10500.00
3	Hotel	100	125	100	7	1200	200 (D) 700 (N)	10.00 (Est.)	—	1.	(P) 6000.00 (L) 8000.00 (I) 3000.00	Company	2¾	2	1	—	24	Direct LowPres.	Pea	17000.00
4	Hotel	85	100	100	7	1000	150 (D) 600 (N)	11.00	4000	1	7000.00 (I) 2200.00	Company	2 (Est.)	2	1	—	24	Exhaust Live.	Buck-wheat	9500.00
5	Hotel	85	250	125	6	2000	400 (D) 1500 (N)	22.50	—	2.	(P) 13000.00 (L) 17000.00 (I) 4000.00	Company	4½	3	3	1	24	Direct LowPres.	Furna'e Coal	34000.00
6	Hotel	100	250	125	7	3000	800 (D) 2000 (N)	27.00	8000	3.	18000.00	Machine	5	3	4	1	24	Exhaust.	Pea	18000.00
7	Hotel	100	250	200	7	3000	500 (D) 1700 (N)	25.00	9000	1. 5.	15000.00	Machine	2	3	3	2	24	Exhaust.	Buck-wheat	15000.00
8	Hotel	100	250	200	7	4000	1000 (D) 2500 (N)	34.25	17000	6.	20000.00	Machine	6	3	4	2	24	Exhaust.	Buck-wheat	20000.00
9	Hotel	85	75	100	6	800	— (D) 600 (N)	12.00	2500	1	5500.00 (I) —?	Company	—	1	—	—	12	Exhaust Live	Pea	5500.00 (I)—?

TABLE II.—GROUP II.

No.	Charac-ter Building.	Dimensions. H.	W.	L.	Stories.	Total Lights.	Load Aver-age.	Fuel, cost per day	Est'm'd cost Plant.	Eleva-tors. E S H	Plant Oper-ation, cost per year.	Ice Supply.	Items In-cluded in Rent	Labor. Eng	Fire men	Oth ers	Hours Service	Heating System.	Coal Used	Total Annual Oper'g Cost
1	Apart-ment House	85	100	100	7	800	— (D) 500 N.	4.70	—	2.	(P) 3000.00 (L) 5000.00 (Est.)	Company	Heat, Light, etc.	2	—	—	24	Direct LowPres.	Furn'ce Coal	8000.00
2	"	85	100	100	7	850	— (D) 600 (N)	4.60	2500	2.	3500.00	Company	Heat, Light, etc.	3	—	—	7	Exhaust	Pea	3500.00
3	"	85	100	100	7	950	— (D) 500 (N)	4.50	2500	3	3400.00	Company	Heat, Light, etc.	2	1	—	7	Exhaust	Pea	3500.00
4	"	85	50	75	7	40 Halls only.	25 (D) 30 (N)	3.00	—	1.	(P) 2000.00 (L) 500.00	Company	Heat, etc.	2	—	—	24	Direct LowPres	Nut	2500.00
5	"	85	50	100	7	500	— (D) 400 (N)	2.75	2500	1.	(P) 3200.00 (L) 120.00	Company	Heat, Light, etc.	2	1	—	9	Exhaust	Pea	3500.00
6	"	85	60	100	7	700	— (D) 500 (N)	2.50	3000	2.	2500.00	Company	Heat Light, etc.	2	—	—	8	Exhaust.	Buck-wheat	2500.00
7	"	85	80	150	7	1200	300 (D) 800 (N)	7.70	6000	2	6000.00	Company	Heat, Light, etc.	2	2	—	18	Exhaust	Pea	6000.00
8	"	85	100	150	7	160 (Halls only.)	60 (D) 125 (N)	7.00	850	2.	4500.00	Company	Heat.	3	—	—	24	Live Exhaust.	Pea	4500.00
9	"	85	77	100	7 & 6	800	150 (D) 500 (N)	2.00	—	2.	(P) 2200.00 (L) 6600.00	Company	Heat, Light, etc.	1	2	—	18	Direct LowPres.	Pea	9000.00
10	"	85	100	100	7 & 6	950	150 (D) 600 (N)	8.60	3500	1.	5500.00	Machine	Heat, Light, Refrigera-tor, etc.	3	—	—	18	Exhaust.	Buck-wheat	5500.00

number of hands; the fuel charge is smaller in the latter, notwithstanding the greater amount of work done. This is due primarily to the use of cheaper coal, the exhaust system of heating, and the utilization of the exhaust steam in numerous ways. By efficient engine-room management and the employment of an isolated plant,—notwithstanding its old style,—the heating, elevator-service, lighting, and refrigeration in the second case are obtained for less than the cost of the fuel and labor in the first. The central station and gas companies together charge $11,000 for lighting. The cost of the ice is more than $3,000 per year. These items constitute a needless waste, which must be charged to the profits of the business. The other similar cases—3 and 4 in Table 1—show the same causes and effects. In neither of the buildings (Nos. 2 and 4) having isolated plants are any extra book-keepers or superintendents engaged; in each case the exhaust steam, after passing through the heating system, is trapped back into the boiler without any ill effects, in apparent contradiction to the assertion made by Mr. R. S. Hale in THE ENGINEERING MAGAZINE for February, 1897, that such a proceeding is "impracticable." The depreciation on plants, such as those described, amounts to less than ten per cent., for in half a dozen similar buildings plants have been running eight or ten years and are apparently in good condition.

In each case the saving effected in one year was equal to the cost of installation, including in the cost of operation the interest and depreciation, and excluding the saving produced by the choice of fuel Numbers 5 and 6 in Table 1 represent very successful hotels. Their prices are moderate, and both cater to a transient class, although No. 6 has also a large residence patronage. No. 6 uses fifty per cent. more lights than No. 5; it has three elevators, instead of two, runs a laundry for two hotels, and makes its own ice. The plant is old-fashioned and much cramped; the boilers are old, as are also the elevators. Notwithstanding these conditions, the cost of running the plant of No. 6 is $16,000 a year less than the cost of running No. 5. One-eighth of this difference, $2,000, is accounted for by the use, in No. 5, of broken coal at $4.50 per ton, while No. 6 burns pea coal at $3.00. No. 5, having no lighting and refrigerating plant, uses live steam for heating and for laundry appliances.

The labor in No. 5 costs $100 a month less than that of No. 6. By not having a plant for lighting and refrigeration, hotel No. 5 has, therefore, saved $1,200 a year on labor. Deducting this from the $2,000 per year credited in hotel No. 6 to coal account, there still remains more than $15,000 a year, which can be due only to the difference in the cost of light and ice from the central supply as compared with the cost of manufacturing these products on the premises.

In No. 6 the excess chargeable to the labor account was $1,200 a year. The coal chargeable to the lighting account may be roughly assumed to be the difference in the actual number of tons burned in each case. The coal cost is, on this basis, $4,400 per year for the ice-making, refrigerating, and electric-lighting plant. The additional charges for water tax, oil, waste, and sundries for No. 6 do not exceed $200 a year; so that we can positively determine the cost of operating the electric-lighting and refrigerating portions of the plant to be less than $7,000 per year. This does not include depreciation charges, which average ten per cent. annually. No emergency supply (gas or electricity) from central stations is provided.

The lighting obtained from the central station and from the gas company costs, in hotel No. 5, more than $17,000, and the ice from $3,500 to $4,000 per year, making the total cost for light and refrigeration about $21,000 per year in this hotel, in contrast with the $7,000 per year for the isolated plant of hotel No. 6,—a saving of sixty-six per cent. In this case the saving that would be produced in hotel No. 5 by the installation of a plant for lighting and refrigerating would pay for the plant in eight months; it would pay for the complete installation, including wiring and fixtures, in less than fifteen months.

Hotel No. 8 is nearly double the size of No. 5. It has a lighting, heating, and refrigerating plant, and six elevators. The cost of operating and maintaining is $14,000 less per year than that of hotel No. 5. Hotel No. 5 is not an unusual case, and other hotels of like size will show similar results.

Next in order of consideration is Group II, comprising apartment-houses. In this class the question of economy of operation yields the position of prime importance to the question of the policy of including light and refrigeration in the rental charges. If the light is to be paid for by the tenants directly, the isolated plant should not be installed, irrespective of other economical conditions, as the tenants will, in time, demand free service. If the contrary is the case, it is invariably advisable to generate the current on the premises in houses containing more than ten apartments.

The usual method in New York apartment-houses is to give light "free" until twelve or one o'clock, after which the tenants pay directly for what they use. In many of these houses gas is used as fuel in the kitchen, and the slight increase in the gas bills for lighting is unnoticed. A number of the more modern apartments include refrigeration as well as illumination, heating, and elevator-service in the rent. The cost of operating a refrigerating plant is not large when the plant is used in connection with the rest of the service, and

the annoyance incident to the handling of ice is avoided; whether the rental returns are increased thereby is still a moot question. A large apartment-house is subject to the same problems as a hotel, except as to the kitchen requirements. The service must be continuous, but, tenants being fewer, it is less severe and costly. The departure in summer of from two-thirds to five-sixths of the tenants is an important factor in the yearly coal-consumption.

Table No. 2 contains statistics of ten houses selected from twenty as most fitted for purposes of comparison. The remainder show similar results.

In the table, the "average load" column shows the number of lights generally burning during the day (D) or night (N) during the winter months. The fuel includes coal, oil, and water. In the column "Plant Operation" "P" refers to operation of plant; "L" to cost of central light and power service. In column "Heating System" direct pressure means employment of live steam directly in radiators. Exhaust is self-explanatory, as are the other columns.

Starting the comparison with large apartment-houses about one hundred feet square and seven stories in height, and comparing apartment No. 1 with No. 2 (or No. 3) we find that the coal bills, averaged for the year, are practically the same, but the labor is increased by one man at $40 per month in No. 2. In No. 1 the heating is done directly by low-pressure steam; in No. 2 by exhaust steam (with additional live steam in very cold weather, perhaps a dozen times during the season). Nos. 1 and 2 have two hydraulic elevators each. No. 3 has three. No. 1 uses broken coal at $4.25 a ton; Nos. 2 and 3 use pea coal at $3.00. Deducting the actual number of tons of coal burned in No. 1 from the amount used in No. 2, to roughly determine the coal required for the operation of the lighting plant in No. 2, the annual difference is found to be 130 tons.

At $3 a ton, this amounts to $390 a year. The oil cost in the two plants is not noticeably different, and the number of lamps used is the same. The additional water-tax in No. 2 is $35 per year. The fuel cost is, therefore, $420 and the extra labor $480 per year, being an operating cost of $900 per year with an additional charge of $300 a year for depreciation and repairs, thus making a total of $1,200 a year as the cost of operating and maintaining such an electric plant in connection with the steam plant. The average lighting current in Nos. 2 and 3 is 250 amperes or 500 lights, and the average time of burning is five hours,—a total of 2,500 lamp-hours per day. The cost of this amount of current from the central station at one cent (list) per lamp-hour, and fifty per cent. discount, would be $12.50 per day, $380 a month, or $4,560 a year. The saving pro-

duced by the operation of these plants in Nos. 8 and 9 paid for them in less than a year in each case.

Apartment houses Nos. 4 and 5, Table II, offer a good basis for comparison of two smaller buildings. Each contains fourteen apartments and one hydraulic elevator, and maintains a continuous service. No. 5 has one hundred more lights than No. 4, and burns these a longer (average) time each day. Notwithstanding the use of a private lighting plant and the increased lighting requirements, the coal cost in No. 5 is less than the coal cost in No. 4. This difference—$7.50 a month—about pays for the extra oil, water, and waste used in No. 5.

The lighting of the halls and janitor's rooms of No. 4 is at the cost of the owner. The average per month during 1896 was more than $40, while for No. 5 (only a few lights during the day when the plant is not run) the average was less than $10. The labor costs $60 a month less in No. 4 than in No. 5. The repairs are all made by the engine-room staff in No. 5, and have not amounted to $25 in cash during the four years the plant has been in operation; so that factor is immaterial. The depreciation of the machinery averages less than ten per cent. on cost of plant, or $250 a year. This makes the total cost chargeable to the isolated plant of No. 5: labor, $720; fuel, $250; and depreciation, $250,—a total of $1,220 a year, from which must be deducted the extra hall-lighting cost of No. 4,—*viz.*, $360 a year, showing the actual extra cost imposed by the operation of a private electric plant in this case to be $860 a year. The cost of the lighting in this building, if supplied from the central station, would be more than $3,000 with the rates at ½ cent per lamp-hour during nine months, and ¾ cent during the three months in which half as many lamps would probably be lighted.

The difference in the cost of supplying light to buildings similar in size to Nos. 4 and No. 5, if supplied from a private plant instead of from a central station, would pay for the plant in a little more than one year.

A system combining the use of electric elevators, pumps, and lights operated from a central station, and low-pressure boilers for heating, has been strongly advocated. No. 9 has such a system, and No. 10, although larger, offers a good basis for comparison.

These houses are built in the best possible manner, and are fitted with all modern conveniences; the rents vary from $1,000 to $2,000. Each has twenty-eight suites, and maintains continuous service. No. 10 has, in addition, a refrigerating plant supplying all the ice-boxes throughout the building. The lighting requirements are also greater. Beside the house-lighting, (identical with that of No. 9) four large

stores and a large hall are lighted half the night and part of the day. No. 9 has two electric elevators. No. 10 has one hydraulic elevator. No. 9 uses low-pressure steam for heating. No. 10 heats entirely by exhaust, and all returns lead to the boiler. No. 9 employs two firemen all the year. No. 10 employs three engineers. No. 9 purchases its light and power (for two elevators and one pump) from an apartment-house near by. No. 10 has its own plant. No. 9 uses ¾ of a ton of pea coal per day. No. 10 uses 3½ tons of buckwheat coal per day. The wages paid in No. 9 are $70 a month less, and the fuel cost is $6.38 per day less, than in No. 10,—a difference of $3,140 per year. No. 9 pays, in addition, more than $550 a month for its light and power, the rates being the same as those of the Edison Illuminating Co. The ice is bought by the tenants. No. 10, therefore, obtains its heating, light, power, and refrigeration for $3,600 a year less than No. 9. This difference will more than pay for the plant required in one year. The large apartments show similar results.

THE MINERAL RESOURCES OF ARIZONA.

By Thomas Tonge.

THE area of Arizona (113,000 square miles) is exceeded in size in the United States only by California, Montana, Texas, New Mexico, and Alaska. Its area is larger than that of Connecticut, Delaware, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont combined. The United States land office credits the territory with 49,000,000 acres (more than 76,000 square miles) of rainless region, where crops cannot be produced. It is no wonder, therefore, that the eleventh United States census (1890) gives the population of Arizona at 59,620 (exclusive of Indians), which subsequent immigration, however, has nearly doubled.

By artificial irrigation nearly 2,000,000 acres have already been brought under cultivation in the territory, and additional irrigation enterprises are under way. Wherever irrigation is possible, the natural climate, giving perpetual sunshine and absence of snow and frost, affords twelve months of growing season, and phenomenal crops of cereals, forage plants, vegetables, and fruits. A man can spend one day at his mine, and the next day "under his own vine and fig tree."

Arizona is rich in minerals,—gold, silver, copper, lead, iron, manganese, coal, etc.,—not less than 40,000,000 acres being classified as mineral-bearing. The total value of the output of gold, silver, and copper during the last twenty years was about $120,000,000.

The annual reports of the United States mint at Washington for the last four years credit Arizona as follows:

Year.	ounces, *gold.*	ounces, *silver.*	pounds, *copper.*	pounds, *lead.*
1893	58,911	2,594,131	44,251,283	3,285,992
1894	96,313	1,539,453	31,162,400	2,625,000
1895	93,580	1,170,193	29,930,046	1,790,149
1896	134,344	963,513	43,334,520	1,026,500

The chief region of metalliferous minerals and mines commences on the north-west, in Mojave county, at the sharp bend of the Colorado river at Callville, and extends south-eastward diagonally across the territory for nearly five hundred miles in a broad belt of high and rugged mountains, including the Bradshaw, the Mazatzals, the White, the Apache and Pinal, the Santa Catalina, the Santa Rita, the Huachucha, and the Chiracahua mountains. The chief towns, min-

BISBEE, COCHISE COUNTY, ARIZONA, SHOWING COPPER QUEEN MINES.

TOMBSTONE, COCHISE COUNTY, ARIZONA.

ing camps, and mining districts are found along or upon the margin of this broad central belt. Commencing at Callville on the Colorado river, we have in south-easterly succession Mineral Park, Hillside, Congress, Jerome, Prescott, Phoenix, Florence, Pinal, Globe, Mammoth, Tucson, Tombstone, Bisbee, Pearce, Arivaca, and Oro Blanco. The Longfellow copper mines and others, of Clifton, lie upon the north-eastern border of the belt, while upon the south-western border we find the celebrated districts of Harquahala, Weaver, Vulture, and many other districts. Passing further westward, we come upon the lava or Piedmontese region of broad and extensive valleys and plains, broken by numerous isolated ridges and ranges, all trending north-west and south-east, parallel with each other and with the main central axis of mountains. These mountain ranges and valleys fill out the area of the territory to the Colorado river on the west and Mexico on the south. They are all mineral-bearing.

The ancient district of Castle Dome, celebrated for its beautifully-formed veins of argentiferous lead ores, lies about twenty miles north of Yuma, in the extreme south-west of Arizona. Silver districts with very large veins carrying silver ore adjoin Castle Dome at the north, and there is a continuous series of mining camps and locations of gold, silver, and copper ores northward along the Colorado river to La Paz, Ehrenberg, Bill Williams Fork, Mojave, and beyond.

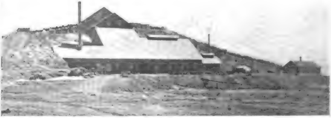
The territory is subdivided into twelve counties,—*viz.*, Apache, Cochise, Coconino, Gila, Graham, Maricopa, Mojave, Navajo, Pima, Pinal, Yavapai, and Yuma. Apache and Navajo have not as yet developed mineral resources to any appreciable extent.

Cochise county (population, 6,500; area, 6,792 square miles) is traversed by the Southern Pacific railroad and the New Mexico & Arizona railroad, and is one of the leading mining counties of the territory.

Bisbee is one of the most prosperous districts in Arizona, and is purely a copper producer, the largest properties being owned by New York capitalists under the name of the Copper Queen Mining Company. The company runs four blast furnaces, smelting about four hundred tons of ore per twenty-four hours, the product being matte, which in turn is "bessemerized," or treated by the pneumatic method in two stands of trough converters of what is known as the Copper Queen or Williams type. The converters give a product assaying 99.2 per cent. fine copper, which is shipped as fast as made. For the year ending June 30, 1896, 10,492 tons, or 20,984,510 pounds, of bessemer pig copper, averaging 99.2 per cent. fine, was produced, which amount will be exceeded in the year ending June 30, 1897. About eight hundred men are employed in the mines and at the smelting works.

SILVER NUGGET FROM ARIZONA, 31 POUNDS 900. FINE.

Tombstone, on the west side of the Dragoon mountains, is a purely silver and gold district —mostly silver. Once having a population of 12,000 people, it has now little more than 1,000 inhabitants, in consequence of the fall in the price of silver and the closing down of the silver mines. The mines are still there, however, and, if silver ever advances to anything like former prices, there will be correspondingly renewed activity in the locality. At present there are about one hundred men "chloriding,"—*i. e.*, taking leases of mines or portions of mines, subject to royalties varying with the value of the ore, and taking out such of the silver ore as is rich enough to ship to the smelter, leaving the lower-grade ore either in the mines or on the dumps. Probably the largest local company is the Tombstone Mining and Milling Company, representing New England and Philadelphia capital. This property has a past production record of several millions of dollars, but, at present, operations are suspended, and only about a dozen men are employed. Other local companies are the Contention



CONTENTION MILL, TOMBSTONE, ARIZONA.

GIRD'S MILL, CHARLESTON, ARIZONA.

CORBIN MILL, CHARLESTON, ARIZONA.

GIRD'S DAM, CHARLESTON, COCHISE COUNTY, ARIZONA.

MILLVILLE, NEAR CHARLESTON, ARIZONA.

Company, representing San Francisco capital; the Grand Central Company, representing eastern capital; and the Empire Company, representing New England capital.

Pearce, about twenty-five miles east of Tombstone, on the eastern slope of the Dragoon mountains, has in about two years developed into a promising producer, although not much development work has yet been done. Rich ore was found in one place at grass roots. The leading property is the Commonwealth Mine, belonging to the Commonwealth Mining and Milling Company, capitalized at $2,000,000, mostly Philadelphia capital. On this property there is a 300-foot shaft, and about 2,700 feet of levels. This mine has large bodies of rich ore which has to be hauled fifteen miles to the nearest railroad point, Cochise, on the Southern Pacific railroad, and is thence shipped at the rate of several cars per day, over one thousand miles, to the smelters at Pueblo, Colorado, the railroad frieght alone being $11.75 per ton. The veins are large, and the croppings extend for more than half a mile. Professor R. A. F. Penrose (who occupies the chair of economic geology of the University of Chicago, and who, with Dr. Whitman Cross, prepared *The Pike's Peak Folio* and *The Geology and Mining Industries of the Cripple Creek District* issued by the United States geological survey) is president of this company. Professor William P. Blake, director of the Arizona School of Mines, says of this mine: "It is another example of the great amount of mineral wealth lying dormant, awaiting the prospector and the aid of capital. The croppings have been known for years, but, being in the low valley land and conveniently under foot and crossed by trails, they were disregarded and neglected until assays revealed the importance of the ore."

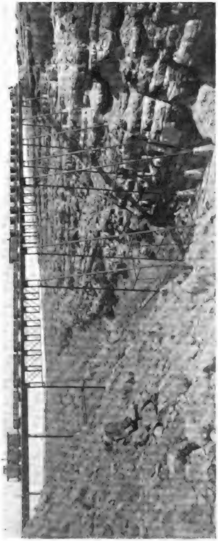
Coconino county (population about 5,000) is traversed by the Atlantic & Pacific railroad, and by the Grand Cañon of the Colorado. It has extensive deposits of coal, as yet only partially developed, and quarries of superior red sandstone. The nine-story Brown Palace Hotel, Denver, was built of this stone, hauled nearly one thousand miles by railroad. The Grand Cañon of the Colorado merits special mention. The Colorado river is formed in southern Utah by the confluence of the Green river and the Grand river, and flows southward until it reaches the Gulf of California, two thousand miles from its principal source. It drains a territory of 300,000 square miles. For hundreds of miles it flows through an appalling fissure at the foot of stupendous cliff terraces, down which descent can be made only at intervals of many miles, and then usually with considerable danger. No photograph will ever give a sense of the immensity of this wonderful phenomenon, and the most stupendous portions of the cañon afford no

SCENE IN THE GRAND CAÑON OF THE COLORADO.

HOVEY'S POINT, CAÑON OF THE COLORADO.

CAÑON OF THE COLORADO FROM HANGE'S.

SCENE IN THE GRAND CAÑON OF THE COLORADO.



BRIDGE OVER CAÑON DIABLO, ATLANTIC & PACIFIC RAILROAD.

coign of vantage for the effective utilization of the camera. What is known to geologists as the Grand Cañon district is mostly in Coconino county, the total vertical depth of the chasm being more than a mile. Recently much attention has been attracted by the mineral discoveries along the Grand Cañon, which include gypsum, asbestos, gold, silver, lead, and extensive and remarkable strikes in copper. The claims already located are said to show unusually wide and extensive deposits in limestone, the ores being chiefly carbonates and oxids, the assays running unusually high. The deposits were first encountered on the crest of the cañon, fifty miles north of Flagstaff, where the Anita Copper Consolidated Company has made the most extensive developments in the district. From this point, it is said, copper can be traced in the development work, as well as by the outcroppings for fifteen miles to the cañon, and from the brink to a depth of nearly six thousand feet into the cañon itself, where the ore deposits are permanent in all the stratified formations of limestone, sandstone, and slate, clear into the archaic granite.

Another account says that the outcroppings of the veins are plainly visible on the faces of the precipitous cliffs. Not along ago a prospector obtained specimens which ran from twenty to thirty per cent. in copper. The cliffs are very steep, and the operators are building trails down their face to reach the veins which show below. In one place they have made a trail three feet wide at a point where the precipice is nearly eight hundred feet high, and are building a station on the vein. They will follow the vein about one hundred feet in from the face of the cliff, and then upraise to the surface, as they believe the vein goes much nearer the surface than the point where it shows. They will store the ore in stations, dumping the waste into the cañon, and, when they reach the surface, will widen the trail, and build a tramway to raise the ore. At some points in the cañon it is possible to build a road near the bottom, having an outlet six or eight miles down the river. Eventually this road will be built, and then all the ore will be lowered from the mines in the face of the cliff to the road at the bottom of the cañon. It is said that the ore is rich enough to warrant these expensive methods.

Gila county (population, 3,500) lies in East Central Arizona, and is the most inaccessible portion of the territory, as it is the only county which has no railroad communications; consequently its development has been retarded. Yet its principal and most important industry is mining, the Globe mining district taking the lead. One single mine—that of the Old Dominion Copper Company (representing Boston and Baltimore capital)—has a record of 70,000,000 pounds of ingot copper, direct at the furnace, 98.5 fine, valued at more than $7,000,000.

The United Globe Copper Company, representing New York capital, is now a heavy producer. The northern portion of the county, near Payson, is rich in gold, there being several stamp mills in operation. The most noted gold producer is the Kasser Gold Mining Company at Lost Gulch, eight miles from Globe. The ore is partly free milling, the concentrates averaging $16 per ton. The production has been at times $16,000 per month.

A district about thirteen miles from the town of Globe was formerly a great silver producer, the silver being found in pockets (usually small, but wonderfully rich) as a chlorid mixed with huge masses of native silver and invariably free from gold. These local mines usually contained from three to seven of these pockets, but in one case only one such pocket was found, which, however, netted the owners $168,000. With the advent of railroad communication, which cannot long be delayed, this county has an undoubtedly great future, as mineral is found more or less from one end to the other.

Graham county (population 9,000 ; area, 7,000 square miles) is tapped by two branches from the Southern Pacific railroad. The principal mining industry is carried on at Clifton and Morenci. The works of the Arizona Copper Company, Limited, are on the San Francisco river at Clifton, and the mines are from four to nine miles distant. An elaborate system of tramways and gravity inclines connects the mines with the works, several locomotives being constantly employed in feeding the plant with ores and transporting the coke, merchandise, and copper of the Company, as well as those of the Detroit Copper Company, hereafter mentioned. One of these copper mines—the Longfellow—has been a steady producer for nearly twenty years. The more profitable ores occur in a lime and porphyry contact. The Arizona Copper Company employs about 750 men, and annually pays more than $400,000 in wages and $12,000 in taxes—about one-fifth of the entire taxes of the county. The Arizona and New Mexico railroad belongs to this company, and runs from Clifton to Lordsburg on the Southern Pacific railroad,—a distance of 71 miles. It is a narrow-gage road, used exclusively in the work of the copper camp. The undoubted richness of the mines has justified the construction of the railroad by the mine owners. By this railroad a special grade of coal is obtained from Cerillos, N. M., from which gas is made in a special apparatus (manufactured in Glasgow) at a much less cost than that of any other fuel obtainable for power purposes. This company, representing Scotch capital only, has invested—with satisfactory results—in the mines, smelting plant, and railroad, $3,500,000.

The Detroit Copper Company, whose mines have been steady producers for more than ten years, has four large blast furnaces and a

SMELTER OF THE ARIZONA COPPER CO., LIMITED, CLIFTON, ARIZONA.

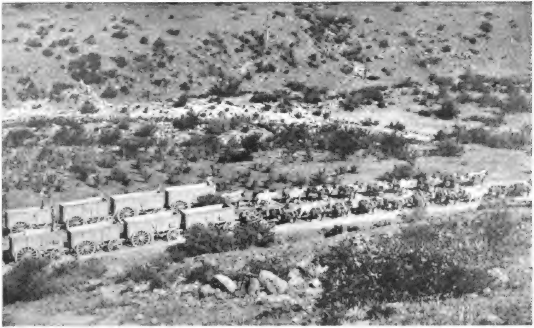
concentrating mill at Morenci, with water-supply pumped from the Gila river, seven miles away. This company also utilizes the Arizona & New Mexico railroad above described. It represents nearly $3,000,000 of Michigan and Colorado capital.

The mountains of Maricopa county (population, 3,100; area, 7,300 square miles) show surface indications of gold, silver, and copper. Until recently there has been no scientific prospecting, but in various localities prospecting and development work are now going on, as well as placer mining, the difficulties in the way being want of transportation and scarcity of water. A number of stamp mills are in operation.

Mojave county (population, 2,200; area, 12,000 square miles) is traversed by the Atlantic & Pacific railroad. The leading mining district is White Hills (fifty miles from the railroad), whose silver-bearing veins, discovered in 1892, have since produced 1,250,000 ounces of silver, besides gold. Of English capital $1,000,000 has been invested in this particular district since June, 1896. There is also an undeveloped gold-bearing region between White Hills and the Colorado river whose ores are not rich enough to justify the expense of a fifty-mile wagon haul and a thousand-mile rail haul to the Smelters in Colorado. There are, also, in various parts of this county, companies and individuals operating gold and silver properties and placers, a number of such silver properties being leased by "chloriders" on royalties.

Pima county (population, 12,000), traversed by three branches of the Southern Pacific railroad, has in operation about one hundred and fifty mines, large and small, producing gold, silver, copper, and lead; more than a dozen mills (none, however, exceeding twenty stamps); and three smelting plants,—one at Tucson, for copper, one at Rosemont, for copper, and one at Nogales, for lead. The Oro Blanco district (100 square miles), in the south-western portion of the county, owes its name to the fact that most of the placer gold is so largely alloyed with silver that the yellow color of the metal is lost, the gold being nearly white. This district has been less developed by workings below the surface than any other mining section in the country.

Pinal county (population, 5,000; area, 5,368 square miles), traversed by the Southern Pacific railroad, has silver mines of too low grade to admit of extensive operations at the present low price of silver. The Silver King mine, owned by California capitalists, is an exception, and is said to have paid $2,000,000 in dividends. It was closed down for some years on the exhaustion of its bonanza deposits, but was reopened last year on the discovery of further deposits of more



ORE TEAMS, PINAL COUNTY, ARIZONA.

YUMA, ARIZONA, SHOWING BRIDGE OVER THE COLORADO RIVER.

ORE ROASTS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

moderate value. The Reymert is another large silver mine. The Mohawk mine is a considerable producer of free-milling gold ore, the veins averaging twelve feet in width. In the county there are nine stamp mills, aggregating two hundred and five stamps.

SMELTERS OF THE UNITED VERDE COPPER CO., JEROME, ARIZONA.

Yavapai county (population 17,020), area 29,236 sq. m., traversed by the Atlantic & Pacific railroad and the Santa Fe, Prescott & Phoenix railroad (the latter connecting the Atlantic & Pacific railroad and the Southern Pacific railroad), has twenty-eight stamp mills in operation, ranging from five to forty stamps each, with a total of three hundred and fifty stamps. This county was, in 1895, the greatest producer in the territory, with $1,258,831 in gold and 322,033 ounces of silver.

The United Verde Mine Copper Company is a New York corporation controlled by Mr. W. A. Clark, of Butte City, Montana. The mine at Jerome furnishes employment to several hundred men. It contains immense bodies of copper ore, carrying also gold and silver. The veins occur in limestone in proximity to irruptive rocks. This mine is believed to net its owners not less than $100,000 per month. The Congress mine and its reduction works, consisting of a 40-stamp mill, cyanid plant, &c., (owned by Arizona and Chicago capitalists) employs three hundred and fifty men. Some time ago this mine was producing at the rate of about 3,600 ounces of gold per month, all from one vein, and, with the opening of a new vein and an increase of the milling capacity, it was expected to double its gold production. The Hillside mine is said to have produced $200,000 in gold and $180,000 in silver. In the Bradshaw mountains the Crowned King mine is the leading gold producer, and the Del Paco in the same district is said to have produced $250,000 in gold. Of the silver mines the Silver Belt has produced $600,000 in silver, the Dos Oris $600,000, and the Peck $3.000,000.

Several hundred men work on placers in this county. They average fully two dollars per day when at work, exclusive of the men who are employed by large companies, of which there are several, utilizing costly hydraulic plants. It is said that $500,000 worth of placer gold was taken from one acre in the Rich Hill district; that a solid $600 gold nugget was picked up on the surface of the ground, and is now in the possession of the Bank of Arizona; and that $120,000 in placer gold was taken from the Walnut Grove district.

Yuma county (population, 3,020; area, 10,138 square miles) is larger than Connecticut, Rhode Island, and Delaware combined. It is traversed by the Southern Pacific railroad. It contains an extensive mineral-bearing belt, as yet comparatively undeveloped and to a large extent not even thoroughly prospected. The most important mine, the Fortuna, owned by California capitalists, competes with the Congress mine in Yavapai county and the Commonwealth mine in Cochise county for the distinction of being the leading gold producer in Arizona, though only a year old. The Fortuna mine and mill are situated thirty miles south-east of Yuma City in a rainless region. Water is pumped twelve miles from the Gila river, through

CEREUS GIGANTICUS, A NATIVE OF THE ARIZONA DESERT, SOMETIMES ATTAINS A HEIGHT OF 60 FEET AND A DIAMETER OF 2 FEET.

a four-inch pipe, overcoming an elevation of 750 feet. The ledge is twenty feet wide, and, so far as opened, continues with depth. In four months 6,300 tons of gold-bearing ore were extracted, producing $220,500. Within less than 2,000 feet from the Fortuna vein are four other distinct, well-defined gold-bearing ledges, one ten inches wide, one two feet wide, one four feet wide, and one averaging twelve feet wide. The ore assays $20, $25, $8 and $12 per ton. Work is proceeding on these ledges. The Haquahala mine (belonging to English capitalists) is utilizing the cyanid process for the treatment of its tailings.

Summing up the mining situation in Arizona, it can be said that, owing principally to its supposed remoteness, the great mineral resources of this territory have not as yet received that attention from outside capital which they fully justify, although nearly all the great mining enterprises so far have been developed by outside capital. The material modification in March last of the anti-alien law affecting the territories will inevitably result in considerable additional investment of European capital. In a number of cases, at least, the necessary water-supply can be obtained by a judicious expenditure of a moderate amount of capital, which expenditure will be fully justified by the richness of the mineral deposits. In other cases the mining properties are of such extent and value as to justify the connection, with the trunk lines, of private branch railroads, thereby reducing the cost of fuel, supplies, ore freights, etc., as has been already done by the Arizona Copper Company. All the conditions of latitude, climate, and weather in Arizona are favorable to continuous mining and shipping the year round. Practically any mine in Arizona can be reached in less than fourteen days from London, the Atchison, Topeka & Santa Fe railroad, and its continuation, the Atlantic & Pacific railroad, being the favorite route from Chicago and the east to southern and middle California. This route has quick through trains, with the finest Pullman and dining-car service and the best-managed eating stations in the United States.

The one great need of Arizona to-day is capital in the hands of practical and enterprising men. This its vast mineral wealth and mining possibilities will certainly attract. With a judicious expenditure, the annnal output in gold, silver, copper, and lead is capable of indefinite expansion, to say nothing of the known deposits of iron, manganese, coal, and other minerals,—onyx, building stone, etc.,—which will eventually be developed and utilized.

THE ELECTRIC PLANT OF THE MODERN TALL BUILDING.

By Frank A. Pattison.

THERE are several factors which determine the success or failure of a tall building, but none play a more important part than the elevators, light, heat, and ventilation. Not many years ago each and every plant installed for these purposes was an experiment, but to-day plants are installed which produce predetermined results with surety. The four requisites specified can now be successfully supplied by the electric plant.

The electric equipment of a building is a plant, the finished product of which is light, heat, or power, made from the raw materials, coal and water. The plan by which an owner can get the best products cheapest and at the same time secure safety for life and property is the one to be adopted. The isolated plant is a factory where electric current is produced on a small scale, and the question whether it is cheaper for an owner to do his own manufacturing, or purchase from the central station, is one to be solved in each case, as like conditions never exist in any two cases.

The first portion of the plant to be considered is the boiler. The water-tube boiler has very wisely been almost universally chosen for installation in large office-buildings. This boiler gives greatest efficiency with greatest security. The shell boiler is not fit for such service. The choice between the return tubular and the water tube is usually prompted by the fact that the latter will give greater power in a given space, and is less disastrous in case of an explosion. A poor fireman makes boiler efficiency an impossibility. It is very difficult to obtain results coinciding with theory; it is sometimes done in single or test runs, but it is a very rare exception to find a boiler plant running regularly with the best possible efficiency. If this is so in large installations, how much more is it true of the boiler plants of the size usually found in office-buildings! The situation of the boilers is determined by municipal and other regulations, so that it is necessary to group the steam-consuming machinery with reference to the boilers. The boiler pressure used to be limited to sixty or eighty pounds, but during the last year several plants have been installed for one hundred and twenty-five to one hundred and fifty pounds, and have made an excellent showing. Time will increase rather than diminish this, as greater economy is being asked for with each new

installation. It is always best to use the steam as soon as possible after it leaves the boiler, and the engines should be placed accordingly. This has been too often neglected in the past. The number and size of boilers are too often determined by the available space; they should be determined by calculating the most efficient combination for the work in hand. The cost of property has compelled vertical rather than lateral extension, so that in future installations more boiler capacity must be designed and arranged to go in the same floor space.

The foundations for boilers and all machinery require very careful study. Piles should never be used, unless it is positively known that they will always be submerged. In some soils it has proved necessary to float the foundations on grillage beams. It is necessary to take especial care to insulate from the grillage, pier, and column work of the building. This is often effected by sand, held in place by brick walls. Heavy felt is sometimes employed. The most satisfactory foundations for a number of units of rapidly-moving machinery has been found to be a single large mass of concrete or masonry. This practice has been followed in a number of plants in Chicago, Buffalo, Philadelphia, and New York. One of the most massive constructions of this kind is found in the American Surety Building on Broadway. It is sometimes best to set the boilers in a caisson sunk to the first substantial stratum. There should be no vibration; if there is the least, it must be absolutely contained within the foundation, and not allowed to enter the structure. For this reason proper supports for steam piping should rest on the floor, or on small foundations, rather than on the steel structure.

The steam piping for engines has not received the careful consideration it should. This portion of the installation is now beginning to develop. The greatest care should be taken to deliver the steam to the cylinders perfectly dry. Expansion and contraction of pipes are to be amply allowed for, and vibration and noise must be prevented. This should be done by removing the cause, not by chasing it from one place to another. Noise may be heard in the upper stories and not below, and will increase rather than diminish.

Given dry steam and a solid foundation, the engine and dynamo in combination become the vital factors in the daily operation of the building. We say combination, because the use of direct-connected machinery has become universal for such work as we are speaking of. This combination is the source of the electric current which moves the elevators, lights the building, propels the ventilating apparatus, and furnishes the exhaust steam whereby the heating is done. Experience has shown that the generating plant should be divided into three or, at most, four units. Occasionally special circumstances vary this.

The size and number of units should be decided upon only after careful study of an accurately-plotted load line. A reduction of the load to as few cylinders as possible is certainly to be sought for. Every cylinder in use should be working with its most efficient load. Upon the result of these calculations also depends the selection of high- or low-speed machinery. It has been general practice up to date to have simple high-speed engines. Problems and conditions are now offering themselves that may in the near future change this. Regardless of the type of engine used, the multipolar dynamo forms the electrical portion of this transformer. These elements should be placed on solid cast-iron sub-bases filled with concrete or sand. These sub-bases are made either in one or two pieces. Some engineers prefer to have all units above fifty kilowatts have a sub-base in two pieces, with the adjoining faces planed and securely bolted. This method of construction has been thoroughly tested, and found trustworthy as to alignment. It is often difficult to get a large casting without a warp or some internal stresses that may be detrimental. The dynamo and engine must run without noise or vibration, and it should be possible to run them without any holding-down bolts, although they should not be so run, except for a test. The engine is usually made with an extended shaft, the extension being occupied by the dynamo armature. Many advocate a divided shaft with a solid or flexible coupling, but, as neither engine or dynamo is of use alone, and the precautions against sudden overload are so refined, it seems unnecessary to take this step. There can be no question of alignment with a properly-constructed foundation and sub-base. The self-oiling of all bearings is desirable, but is not yet universally demanded. It will not be long before all engineers will demand this. Indicator cards taken for friction load with and without self-oiling arrangement make a very interesting study, and will, in the end, create a universal demand on the part of engineers for self-oiling machinery. The possibilities of given pressure of steam in the known dimensions of the cylinder should be delicately weighed against the output of the dynamo to which it is to be attached, in order to have the two pieces of apparatus form a proper unit of power. The dynamo should be compound wound, unless special connection with other apparatus prohibits. It is now considered good practice to use a broad commutator and a number of carbon brushes. Up to the present year 110-volt dynamos for light, and 110 or 220 volts for power, have been used, but the advent and commercial success of the 220-volt lamp will give engineers wider scope for economy, and lead to the use of higher pressure without sacrificing the advantage of interchangeability always to be sought.

The most trying work the generating plant has to perform is the supply of current for running the elevators. The load will vary much, and between wide limits. This prohibits the running of lights and elevators from the same dynamo. A storage battery must be supplied to take the current not wanted by the elevators, or else the elevator generating units must be subdivided and placed upon the same shaft run by one engine, thus allowing the several elevators to equalize the load. The former plan is used in several large buildings in Chicago and New York. The latter is about to be tried in the New York Athletic Club, and, as the load is not sufficient, a lighting generator has been placed on the same shaft. Of course, the object to be attained is to keep the load line as straight as possible, and of such height as to insure economy in the cylinder of the engine.

The switchboard is a very important element in the electric plant of the modern tall building. Every wire from each dynamo should pass to its work through the switchboard. This must be equipped with proper instruments for showing the condition and work of each dynamo, and the necessary switches for the necessary sub-division and control of the various parts. This should be absolutely fire-proof in every part, and placed where there is proper circulation of air and careful protection from meddling and accident. It is too often tucked in some corner and given too little attention.

The storage battery has developed into an important part of the electric equipment of a building. It may perform one or several of the following functions: supply current to take care of the peak of the load; supply current for light during hours of light-burning; act as a balance spring between the power motors and bus-bars. Storage batteries are not needed in all large buildings, but the time is fast approaching when the designer of large isolated plants will have to give very careful consideration to this portion of the equipment. A great deal of the trouble of the past has been due to too small batteries, and that evil has not entirely disappeared. The line showing the duty required of the storage battery should be carefully plotted for each case, and the specification so drawn as to clearly show what work it will have to do. Too many batteries are installed without a very definite idea as to why or how much they are to do, or how long a time they are to be allowed to perform their work.

A storage battery should be installed in a room entirely shut off from everything else, and where good ventilation can be obtained. The cells must be so arranged that each can be carefully inspected and tested. If the cells are large, they should not be placed one above the other, unless absolutely necessary. The floor should be pitched slightly, so as to be drained at one or several points. The size of cells,

the question of end-cell or counter-cell regulation, the number of cells, and the method of charging, must be decided upon for each installation, as no general rule can be made. The switchboard containing the instruments and switches for regulation should be placed near to, or built as part of, the generating plant switchboard. Too great care cannot be taken to keep the fumes from the battery away from everything. They should have no outlet, except to the outer air.

In such a climate as that of New York, sufficient exhaust steam can be derived from the electric-plant engines to heat the building, except in extreme weather. The steam, after it has passed through the feed-water heater, is reduced in pressure and passed into the pipes of the heating system. The back pressure on the engines caused by using the exhaust for heating the feed water and the building should never exceed five pounds. As a matter of fact, it is the exception when it reaches five pounds.

The pumps for feeding the boilers, for raising water for the building to the tanks on the roof, and for lifting the drip water to the sewer are steam pumps. There is no reason why this work could not be done with electric pumps. They are economical and very easily controlled.

The tall-building craze has spread rapidly, and it will take years to work out the requirements in the various departments. The electric elevator for skyscrapers is still in the development period, although in many buildings it is an important element of the plant. At the present time it is not possible to define the practice of the day, because each new plant brings out new methods and new apparatus.

One subject should be touched upon which is of vital importance to all connected with the erection of a modern tall building, and especially to the owner,—namely, the spaces in which the machinery is placed, commonly called the engine room. This should be light, thoroughly ventilated, and constructed of such materials as may be easily kept clean. Thousands of dollars worth of machinery is often placed in little more than a hole, where it cannot possibly get proper attention, and where the heat partially disables the best of men. This space, of course, is limited by circumstances, but there is no reason why the walls and floors should not be of easily-cleaned material, why light should not be abundant, or why ventilation should not be perfect.

THE HISTORY, STATUS, AND POSSIBILITIES OF ACETYLENE.

By Henry Harrison Suplee.

THE interest developed in the past few years in the use of acetylene as an illuminating agent makes an account of the various investigations into its properties and use appropriate at the present time.

While the development of the commercial side of the subject has been most active in the United States, the scientific investigations and researches upon which our more exact knowledge is based are mainly due to the labors of the French chemists and physicists, notably to MM. Berthelot, Vieille, Moissan, Bullier, and others, and to the Swiss scientist, M. Raoul Pictet.

Acetylene was first discovered by the English chemist, Edmund Davy, and brought by him to the notice of the British Association in 1836.* By heating carbon and potassic carbonate, he obtained a black substance which, when treated with water, gave off a gas of the composition $C_2 H_2$, and which he called a "gaseous bicarburet of hydrogen." Berzelius, in the same year, found the black substance from which Davy had prepared his acetylene to be carbid of potassium. In 1839 Professor Torrey first noticed, in some copper pipes used in New York tor conveying gas, the presence of a brownish deposit, which proved to be an acetylid of copper, and which was found to be violently explosive under the influence of shocks or of slight elevation of temperature. This revealed the presence of acetylene in ordinary illuminating gas in small proportions, varying from 0.06 to 1 per cent. Similar observations were made in Europe by Crova and by Boettger, the latter preparing the acetylid of copper by passing illuminating gas through a solution of protochlorid of copper. Quet applied the same test to the gas produced by the decomposition of alcohol by the electric spark, or by heat, and also found that, when the copper solution was replaced by one of silver, a fulminating acetylid of silver was formed.

Calcium carbid, $Ca C_2$, was first prepared by Wöhler, in 1862, by raising an alloy of calcium and zinc, mixed with carbon, to a welding heat; and he observed that the calcium carbid thus produced gave a reaction with water similar to that produced by Davy with carbid of

* Brit. Assoc. Rep. 1836. Pt. 2, p. 62.

potassium, acetylene gas being given off at ordinary temperatures. Wöhler announced his intention of continuing these researches, but his death brought the investigations to a stop.

Our most complete knowledge of the properties of acetylene and its compounds, however, is due to the eminent French chemist, Berthelot, whose researches may be found in the transactions of the French Academy and Chemical Society since 1855. Following out his special investigations in synthetic chemistry, he passed hydrogen through a globe in which an electric arc was maintained between two carbon points. The gas thus treated, being subsequently passed through an ammoniacal solution of copper, formed acetylid of copper, thus proving the direct synthetic formation of acetylene. This experiment, performed in 1866, has become famous as the first example of the direct synthesis of a hydrocarbon. Those who are interested in the wide range of possibilities in organic synthesis which the commercial production of acetylene may open can do no better than follow the researches of M. Berthelot; but, as we are here discussing the production of acetylene as an illuminant, we must leave the synthetic side of the subject.

For commercial purposes acetylene is produced by the reaction of water with certain metallic carbids, and it is to the production of these carbids, and especially calcium carbid, that attention is now directed. Davy, as we have already seen, produced carbid of potassium, and Wöhler carbid of calcium, while, in the course of his researches, Berthelot has also made carbid of sodium by first producing acetylid of sodium and then converting it into carbid by heat. A carbid of barium has been produced by Maquenne, by several laboratory methods, but the cost bars all these, except carbid of calcium, from commercial consideration as sources of acetylene.

The production of calcium carbid in the electric furnace is one of those developments that naturally comes with the progress of the art; and, with careful experimenters at work in Europe and America, it is not surprising that almost simultaneous accounts of its discovery should come from various countries. The electric furnace had been in use from the time of the first production of the electric arc by Sir Humphry Davy in 1802, but it was not until the advent of the modern dynamo that it became a commercial possibility. In 1879 Siemens made a powerful electric furnace, in which he repeated on a large scale the experiments of Davy, and in 1885 Cowles applied the furnace to the production of the alloys of aluminum from corundum. The well known electro-chemist, Dr. Borchers, conducted experiments for several years, in Germany, as a result of which he stated, in his treatise on electro-metallurgy, published in 1891, that "all

oxids may be reduced by the action of carbon heated electrically." In France, Moissan made many experiments with the electric furnace, and at the close of 1892 he presented to the French Academy a memorandum announcing the fusion of lime and its partial combination with the carbon electrodes to form carbid of calcium, followed early in 1894 by the presentation of specimens of pure crystallized carbid in quantity.

In August, 1894, Mr. T. L. Willson, of New York, took out a patent for the production of carbid of calcium by heating a mixture of lime and carbon in the electric furnace, as a result of experiments conducted by him since 1888. Mr. Willson's experiments were originally intended by him to reduce refractory metallic oxids in the electric furnace in a manner similar to that of Cowles and Heroult. The attempt to produce metallic calcium resulted in the production of a slag which, by its effervescence with water, was recognized as carbid of calcium, and, from a published letter from Lord Kelvin to Mr. Willson in October, 1892, it appears that the latter was then in possession of the process.

Subsequent modifications have been almost entirely in the details of the furnace and methods of handling, and at the present time carbid is being manufactured commercially at Niagara; at Froges, in France; at Neuhausen, in Switzerland; and experimentally in many other places.

Calcium carbid, the prime agent in the production of acetylene, is a hard, dense material of a brownish-black color, usually with a crystalline fracture, and a specific gravity of 2.22 to 2.26. Though quickly decomposed by water, it is otherwise a peculiarly inert substance, and in a dry atmosphere it is practically without odor. The ordinary moisture of the air decomposes the exterior surface slowly, evolving acetylene with its characteristic odor, and converting the exterior of the lumps with a coating of lime.

The rapidity of the reaction with water is in marked contrast with the carbid's indifference to other substances. A lump of carbid thrown into a vessel of water will at once cause a strong ebullition, the acetylene bubbling up through the water to the surface, where it may be ignited, burning with a luminous, smoky flame.

When this gas is collected in a suitable holder, and delivered to proper burners, it forms one of the most brilliant illuminating agents yet discovered. The light is without the glare of the arc lamp, or the reddish glow of the incandescent loop, and the flame, in color and temperature, is especially grateful to the eye.

Photometric tests have shown that, for equal volumes consumed, acetylene possesses about twelve times the illuminating power of the

best coal gas, burned in the ordinary burners, at the same time producing decidedly less heat.

These facts being known, it appeared that the commercial production of calcium carbid at a reasonable price had placed a most valuable illuminating agent within immediate grasp. A closed vessel containing carbid and provided with means for introducing water and drawing off the gas constituted a generator of unparalleled simplicity and convenience. Soon also it was found that the gas could be liquified, either by pressure or cooling, or both, thus making it available for portable uses, such as car-lighting and the like; in fact, the advantages of the gas seemed almost unlimited.

However, practical difficulties soon appeared in connection with the generation and use of the gas.

Corrosion in the metal fittings and connections, with the formation of metallic acetylids, became apparent. The generator often became highly heated, and the temperature did not always diminish upon the stoppage of the water, nor did the formation of gas cease. The burners became choked, and the illuminating power of the gas varied, and, altogether, the results of experience showed that much was yet to be learned about the generation and use of acetylene. Added to this came the fear of explosions; particularly with the liquefied gas, several dangerous and some fatal accidents occurred, rendering it evident that the new illuminant needed thorough investigation.

The very extensive experiments of MM. Pictet, Berthelot, and others, however, have resulted in so large an addition to our knowledge of the causes and remedies for these objectionable features that we may feel more and more assured that, with the exercise of ordinary care and intelligence, and the use of apparatus constructed in accordance with the knowledge thus acquired, acetylene will yet become a safe, successful, and economical illuminant.

In order to discover the conditions existing in connection with the generation of acetylene by the union of calcium carbid and water in a closed vessel, Pictet made a most thorough experimental investigation. Assuming the behavior of the materials to be altogether unknown, he prepared an apparatus consisting of a strong steel cylinder communicating with a steel coil closed at the end and submerged in water. In the cylinder he placed five kilograms of carbid, and bolted it close, having placed in it also a number of weighed wires of various metals, to observe the chemical action upon them. A powerful force-pump permitted the introduction of water against high pressure, and pressure gages and thermometers enabled the pressures and temperatures to be closely observed. The entire apparatus was tested under a

pressure of three hundred and fifty atmospheres, after which all the air was exhausted, so as to insure the presence only of the materials which it was intended to investigate.

A small quantity of water was first introduced, and the generation of acetylene commenced. During the first ten minutes the pressure steadily rose in exact proportion to the quantity of water supplied, after which it remained stationary at a value corresponding to that of liquefaction at the temperature of the water surrounding the coil. On the introduction of more water, the temperature rose rapidly, and in a quarter of an hour it had reached the boiling point. The pressure of liquefaction also began to rise, probably due to the generation of impurities which would not liquefy. Suddenly the pressure gages gave a jump to nearly three hundred atmospheres, and a violent shock jarred the ground. In an instant the entire gaseous contents of the generator and coil had become dissociated with explosive force. The hydrogen had been liberated, and the carbon deposited in the solid form, and the acetylene was no longer in existence. The strength of the apparatus had prevented any accident, but the force of the explosion was such as to give unmistakable demonstration of the violence with which, under certain conditions, acetylene will explode. Upon opening the cylinder, it was found to contain a coating of carbon, in an extremely fine state of subdivision, while the metallic wires showed various degrees of corrosion. A number of repetitions of this experiment gave substantially the same result, and proved that the generation of acetylene in closed vessels by adding water to calcium carbid may produce pressures and temperatures sufficiently high to cause disastrous explosions.

Having this knowledge, it is not difficult to avoid the occurrence of these conditions, and various arrangements of apparatus have been devised by Pictet and others to avoid the possibility of such dangers. Excessive pressure can be avoided by providing capacity for the maximum production, or by suitable safety-valve or relief chambers. Dangerous temperatures can be checked either, as suggested by Pictet, by using coils of pipe containing cold circulating brine from a refrigerating machine, or, more simply, by plunging the carbid into an excess of water to absorb the heat. Whatever modified details be adopted to secure these ends, it must be admitted, as a result of these experiments, that the adding of small quantities of water to comparatively large masses of carbid is not only unadvisable, but positively unsafe.

Apart from the results obtained by Pictet, the researches of Bullier, Vieille, Pintsch, and others have shown that even the moderate rise in temperature of the exterior of lumps of carbid is undesirable from the point of view of economy. The principal impurities found

in acetylene are ammonia, sulphuretted and phosphuretted hydrogen, nitrogen, and carbonic oxid. Of these the ammonia is very objectionable, because its presence greatly assists in the formation of the fulminating acetylids of copper, wherever the gas comes in contact with copper or copper alloys. The other impurities detract from the illuminating power, and add to the odor and to the toxicity, and these are much more readily formed when the carbid is hot than when it is kept at a moderate temperature. It is also found that the hydrated lime which is formed as a result of the decomposition of the carbid will absorb water when warm, which it again gives out on cooling, so that, while the generation of gas may have apparently ceased with the stoppage of the water-supply, it will recommence when the cooling lime gives up a portion of its moisture to the as yet undecomposed carbid. For these reasons those who have had much experience with the generation of acetylene prefer to plunge the carbid entirely beneath a comparatively large volume of water, generating the gas in a cool condition and preventing many uncertain and undesirable reactions. Pictet insists that this is the only safe method, and it certainly has much to recommend it.

When the gas is thus generated under water, the temperature will rise only a few degrees, if sufficient water be present. One pound of carbid evolves about nine hundred British thermal units while generating about 5½ cubic feet of acetylene, so that it would raise the temperature of six pounds of water from 62° F. to the boiling point; dropped into 100 pounds of water, or about 12 gallons, it would raise its temperature only 9 degrees. The presence of the water also serves to absorb nearly all of the ammonia, and much of the sulphuretted hydrogen, although, when saturated, it should, of course, be renewed. Acetylene generated in this manner may be still further purified, and the entrained moisture removed, by desiccating materials, after which it will no longer attack copper, or foul the tubes or burners, and will give uniformly its maximum illuminating effect.

Against such acetylene there is no reasonable objection on the score of danger. It is probably no more poisonous than ordinary illuminating gas, while its characteristic odor causes leaks to be readily detected. A number of experiments by Vieille and Berthelot have demonstrated that at atmospheric pressures a decomposition originated at any point is not propagated through the mass of the gas. Neither a spark, an explosion of fulminate, or direct contact with flame causes any action beyond the immediate vicinity of the heat. When, however, the gas is subjected to a pressure greater than two atmospheres, it exhibits all the properties of an explosive mixture; hence the danger ine is clearly and definitely marked.

Mixtures of acetylene are, or are not, explosive, according to the proportions of the two components, the limits being between three of gas to one of air, up to twenty of gas to one of air, this being a somewhat wider range than is found with ordinary illuminating gas; with the care now taken against approaching leaks with lights, there is no greater danger.

The use of liquefied acetylene has been advocated for portable lighting, especially for railway carriages, and in many ways it is eminently adapted for such a purpose. In this form, however, even greater care is necessary, as it has been from ignorance of the properties of liquefied acetylene that the most disastrous casualties have occurred.

As we have already said, acetylene is readily liquefied by pressure and cold. The critical point, above which it cannot be liquefied by pressure, is 98.6° F.; at the freezing-point it requires 21.5 atmospheres, and at 67° F. 40 atmospheres, to reduce it to the liquid state. At a temperature of 62°F. the liquid is about 1-400th the volume of the gas, so that one cubic foot of the liquid acetylene will produce 400 feet of gas; hence the advantages for car-lighting appear at once. In order to use the liquefied gas, it is necessary only to provide the cylinder with a reducing valve to maintain a uniform pressure of two to four inches of water on the main leading to the burners. No other apparatus is required.

As the pressure due to the action of the gas is not excessive, there appeared no good reason to apprehend danger in using the liquefied gas in this manner, but the occurrence of fatal explosions in Berlin, Paris, New Haven, and elsewhere showed that there must be some reason, not as yet understood, for the apparently mysterious rupture of cylinders tested at pressures far beyond the liquefying pressures of the gas. The investigations of Pictet have revealed what is doubtless the cause of these explosions,—namely, the extraordinary expansion of the liquid with changes of temperature. Liquid acetylene is, without doubt, the most expansible liquid known. A given volume of the liquid at 32° F. becomes 1.07 volumes at 62°, and 1.24 volumes at 96°, thus expanding fully one-fourth of its original volume at the temperature of a midsummer day, or of a factory engine-room. When the cylinders containing the liquefied gas are only about half filled, the room for expansion is sufficient to provide for the increase in volume at any temperature at all likely to be experienced, and M. Pictet has fearlessly subjected such cylinders to the temperature of boiling water without accident. In the absence of this precaution the enormous expansive force of the liquid not only ruptures the vessel, but releases the liquid contained therein at a pressure at which its ex-

plosive power practically equals that of gun cotton. Since the quantity of liquid contained in a cylinder can readily be determined by weight, it is perfectly practicable to control the filling so as to provide for the expansibility of the liquid ; but, until this point is thoroughly understood and faithfully observed, the liquid acetylene must be regarded with caution. In no case, however, should explosions of the liquefied gas be confounded with supposed dangers of the gas at ordinary pressures, as the two are absolutely distinct.

Another method of storing acetylene in small bulk has recently been brought to notice in Paris by MM. Claude and Hess. This consists in dissolving the gas in acetone, a liquid which has the property of absorbing at atmospheric pressure thirty-one times its own bulk of acetylene gas. The gas may be dissolved in the acetone under pressure, and withdrawn from it by relief of pressure, much in the same manner as the gas in the siphons of carbonated waters is dissolved and withdrawn. This affords a convenient and safe method of storing a large volume of the gas in small bulk, and appears to be a valuable solution of the problem. The experiments of Berthelot and Vieille* have shown that, if the pressure under which the gas is dissolved in the acetone does not exceed about one hundred and fifty pounds to the square inch, there is no danger of explosion, but that at higher pressures the solution begins to partake of the properties of liquefied acetylene, and becomes subject to the same dangers.

With our present knowledge, the safe and satisfactory use of acetylene is within the limits of ordinary temperatures and at pressures below two atmospheres, and it is within those limits that the widest range of usefulness will doubtless be found.

The commercial side of the problem is one which, at the present state of experience, is limited by one controlling factor,—the cost of calcium carbid. All other elements are similar to details of ordinary manufacture, and can be determined with a reasonable degree of accuracy. Until a wider experience can be had, it is impracticable to predict just what may be expected from improvements in the manufacture of carbid. When the subject was first brought before the public, only small quantities had been made, and estimates as to the price at which it could be made by the ton were much lower than any price yet realized. The chief element of cost in electric smelting is that of power, and it is not difficult to compute the power required to effect the chemical and thermal reactions involved in the conversion of lime and carbon to calcium carbid. As one example of such a computation, the figures of M. Pictet are given, and, it may be added, these agree very closely with those of other physicists.

*Comptes Rendus, May 10, 1897.

Taking the formula:

$$CaO + 3C = CaC_2 + CO,$$

and substituting the equivalent weights, we have:

$$\begin{array}{l} CaO + 3C = CaC_2 + CO \\ \;\;56 + 36 \;\;= 64 \;\;\;\; + 28 \end{array}$$

1. The heat necessary to raise 36 grams of carbon to 3,000° C.:

$$0.036 \times 3{,}000 \times 0.46 = 49.68 \text{ calories}$$

2. The reduction of 56 grams of lime to 40 grams of calcium and 16 grams of oxygen involves a work of dissociation equal to 132 calories.

3. The heat necessary to raise 56 grams of lime to 3000°: = 33.6 calories.

From these are to be deducted:

4. Heat produced by the combustion of 12 grams of carbon to carbonic oxid: 28.59 calories.

5. Heat of formation of carbid of calcium, endothermic reaction: = 0.65 calories.

Taking the algebraic sum of these quantities of heat, we have, for the production of 64 grams of carbid of calcium, an expenditure of 184 calories, which is equivalent to 2,856 calories for one kilogram, this being the theoretical value, assuming an efficiency of 100 per cent. for the apparatus. This is equivalent to 5,141 British thermal units per pound of carbid, and, as one h. p. h. is equal to 2,545 B. T. U., the minimum theoretical amount of power required to generate the heat necessary to produce one pound of carbid per hour is 2.02 h. p.

This agrees fairly well with the limited information available as to the actual amount of power required in practice, so that, with an allowance of, say, 75 per cent. efficiency, the actual power required can be determined, and the question becomes one of economical power. The existing establishments are at points where water power is available,—at Niagara, at Neuhausen, below the Falls of the Rhine, and at the Heroult aluminum works at Froges,—and the influence of competition should soon determine a definite market price based upon the cost of manufacture.

From the foregoing discussion, while it may be too soon to draw definite conclusions upon all the points at issue, we may infer that acetylene as an illuminant has a positive value which for many purposes is immediately available; that it can be produced and used without greater risk or danger than is involved in the use of ordinary illuminating gas; that, in the compressed or liquefied form, it should be handled only by experts under well-ascertained conditions; but that notable advances must be made in its economical production, if it is to compete broadly with coal and water gas as an illuminating agent.

REVIEW OF THE ENGINEERING PRESS

The Smoke Nuisance.

MORE than ever the abatement of the smoke nuisance is demanded under the belief that its abatement is possible, and that the industrial interests which create it ought not to have any right to profit at the inconvenience and expense of immediate neighbors. The board of health of Philadelphia having requested The Franklin Institute to appoint a committee to coöperate with the board in the effort to abate the nuisance, the question came up for discussion before that body in April. The discussion was opened by Mr. A. E. Outerbridge, Jr., whose very able treatment of the subject (published in the *Journal of the Franklin Institute* for June) clearly sets forth the extent of the grievance, not alone in Philadelphia, but in other cities. He gave as the chief cause of the nuisance the increase in the use of bituminous coal in urban industries, and presented a *résumé* of the scientific investigations directed to smoke prevention, together with a statement of the principles underlying the problem. In the course of his remarks he brought out the fact that the "development of modern sky-scraper office-buildings surrounding industrial establishments and far overtopping their chimneys is rapidly changing old conditions," thus making the question of smoke prevention so important that it can no longer be neglected. The failure of some of the smoke ordinances passed in a number of western cities where soft coal is used is attributed to the ignorance of legislators. "An ordinance more than ten years old, making it a penitentiary offence for an individual to permit black smoke to escape from his chimney," is cited. "The very absurd and preposterous nature of the penalty made the ordinance practically a dead letter from its inception." The extent of the nuisance and the grievous damage inflicted are shown by quotations from a report that Chief Smoke Inspector Adams, of Chicago, made to the board of health of the city. Mr. Adams divides the people of Chicago into two classes: "(1) those who create a smoke nuisance; (2) those who are compelled to tolerate a smoke nuisance. One class has radical champions, who maintain that smoke is an irrepressible necessity—a concomitant of the commercial and manufacturing supremacy of Chicago; that smoke not only is not unhealthy, but that it is an actual disinfectant; that the advocates of smoke abatement are visionary sentimentalists, and, in a general way, they are emphatically opposed to any agitation of the subject." The second class "declare that the smoke nuisance is a positive menace to the health of citizens; that it has resulted in an alarming increase in throat, lung, and eye diseases; they point to ruined carpets, paintings, fabrics, the soot-besmeared façades of buildings, and to a smoke-beclouded sky, and demand that the smoke inspector do his plain duty under the law." In Chicago, there are more than 15,000 steam boilers, 12,000 of which consume soft coal. These are distributed over an area of 186 square miles. Inspector Adams says: "I know of an instance in which a restaurant firm so consumed $600 worth of coal as to cause an actual damage to adjacent property exceeding $25,000." He also cites "an apartment building, under the management of a receiver, protected by the court against the enforcement of the smoke ordinance," which, he states, "ruined the furniture and furnishings of every residence for two blocks in its neighborhood, and depreciated the value of adjacent real estate more than one-third of its former value." Mr. Outerbridge then reviews the different solutions of the smoke problem hitherto proposed. Theoretically, the best solution is the use of smokeless fuel. Such a fuel is petroleum. But for various reasons, among which is an inadequate supply, "we may as well abandon the idea of the probability of the general use of petroleum as

a fuel in this country." Secondly, the use of anthracite is not accompanied with the nuisance of smoke, but "it is an unfortunate fact that this admirable fuel has been proven unable to compete successfully with bituminous coal in the race for industrial supremacy." The anthracite output in 1895 was double that of 1880, while the production of bituminous coal was more than three times as great. Dr. R. H. Thurston, following Mr. Outerbridge, confirmed the statement that the smoke nuisance is preventable. He regards the question as largely a matter of finance; that is to say, the cost of smoke-abatement is the principal obstacle to its full accomplishment. Classifying the preventives which are more or less effective, he named legislation, operating through boards of health, as being, in his opinion, most likely to be effective. He does not credit the statements made with reference to its unhealthfulness, rather regarding the presence of some free carbon in the air as aseptic in its effects. A system of fines that would make the production of smoke more costly than its prevention ought to be imposed. "The difference in the costs of bituminous and anthracite coal being taken as, we will say for illustration, $2 per ton, the proprietor can bear a tax of that amount, if it should prove necessary on the part of the city to impose it; and this means about $4 per annum per square foot of grate surface. A fine of twenty-five to fifty cents a month per square foot of offending grate will thus presumably abate the nuisance under such circumstances. Very likely a much smaller sum may prove sufficient; but that is a matter for trial, and one to be settled by experience." Mr. William R. Roney, Professor L. N. Haupt, Col. Thomas P. Roberts, of Pittsburg, and others contributed to this interesting discussion. The consensus of opinion is that abatement of the smoke nuisance is possible. The increased cost of smokeless combustion will be the chief incentive of opposition to a general and effective movement in this direction. It has always been the case that great public reforms have been resisted by private interests.

Pot Holes in the Anthracite Region.

In an article by William Griffith in *Engineering News* (June 24) a description of these freaks of the glacial period is presented, and the action of water flowing through a considerable distance in streams (probably through crevices in the ice), aided by the stones kept rolling and rocking or swept about by the force of the water-falls, is assigned as the cause of these holes. Pot holes are often found in the neighborhood of channels gouged out by the irrepressible force of the superincumbent glacial mass, which carried along with it quantities of abrasive materials (such as sand and gravel), now found deposited in the channels and in the pot holes, the latter being generally filled with glacial drift. What is known as the "buried valley" of Wyoming is one of these glacial channels. In 1884, one of these pot holes was discovered in the anthracite coal regions, "when one of the chambers of the Eton Colliery at Archbald, owned by Jones, Simpson & Co., and located on the mountain-side high above the water-level, was drifted against a mass of round stones of all sizes, from pebbles to boulders a foot in diameter. Subsequent investigation revealed the existence of an oval-shaped shaft, from twenty to forty feet in diameter, worn through the rock from the surface. The walls of the pot hole were smoothly worn and fluted, and corrugated spiral curves showed the unmistakable action of water and stones. This pot hole had cut completely through the coal bed, and among the boulders in the bottom of the hole were quantities of of round lumps of coal, which had evidently been cut from the vein." This pot hole is now used as an air shaft for the mine. A wall has been built around the top, and "it may be inspected at any time. A second pot hole was found later at the same mine, about 1,000 feet northward of the first. It has, however, never been cleared of its contents of glacial drift." About twenty years previous to the discovery of these pot holes, a cave-in occurred at the Wyoming colliery, now the Lehigh Valley Coal Co., at Port Bowkly Station, on the Lehigh Valley Railroad. It was supposed that this

was the result of one of these pot holes, since the mines were filled with *débris* like that found in the other pot hole. The mine has since been recovered. Two serious mine accidents attributed to pot holes have occurred in the "buried valley," of Wyoming, since the Archbald pot holes were discovered. The latest of these occurred on March 1, 1897. On the afternoon of that day "the surface under the Wyoming post office began to settle. The mines were idle, and no one was working at this point. Inspection by the mine officers revealed the fact that a break had occurred near the face of the most advanced workings at the edge of the solid coal, resulting in a flow of water and quicksand, filling a large area of the workings, and carrying the *débris* to the foot of the shaft three thousand feet away." The volume of the flood, however, gradually diminished, and, the pumps being adequate for the emergency, the water in a short time began to subside, the flow of sand stopped, and the break checked and filled, not, however, until about seven thousand cubic yards of quicksand had been washed into the mine, causing a surface depression or cave about 2,300 feet in diameter and 25 feet in depth, which engulfed the pot hole completely and did some damage to three dwellings. The circumstances of this accident, and the evidences accompanying it, show unquestionably the presence at this point of a glacial pot hole of sufficient depth—fifty to seventy-five feet at least—to cut the vein of coal in which the mines were operated. The first rush of sand and water carried with it a quantity of water ground lumps, which were deposited near the shaft and in the gangway leading therefrom. Quantities of coal, worn round and smooth, were found deposited with the quicksand at points close to the work, showing that the bottom of the hole probably cut through the coal-vein. Fortunately, the miners had left their work a few hours before the break occurred. A stoppage of the mine for about six days resulted, but it is now in operation again. This is an abstract of a paper read at the meeting of the Anthracite Coal Operators' Association for 1897.

A Notable Feat in Irrigation.

SOME of the difficulties which have to be encountered by engineers engaged in erecting irrigation works are recounted in an interesting popular article in *Harper's Weekly* (June 12). The cultivation of arid lands depends, not upon the amount of land which can be cultivated in the heated region, but upon the water-supply which can be obtained by engineering methods. As a rule, irrigated lands have proved very profitable and productive, and the problem of obtaining water for irrigation is one of the most interesting that can be presented to the civil engineer. In the article named a feat in irrigation is described which, we think, is not generally known to the American public. This was simply a diverting of water from one watershed to another on the opposite side of the ridge. "This plan comprehends nothing less than the appropriating from the Pacific-slope water to supply a deficiency on the Atlantic slope, or of drawing water from the Grand river in Colorado to supply the farmers of the Cache la Poudre valley with water for their crops, or *vice versa*." This plan has already been carried out in the diversion of water from the head of the Big Laramie river, which, rising in Laramie county, Colorado, flows northward into the North Platte river, the head of the Cache le Poudre river rising in the same county and flowing in an easterly direction and emptying into the South Platte. "This feat has been accomplished by a company which owns a large system of irrigating ditches and reservoirs in the Cache la Poudre valley. Both the Big Laramie and Cache la Poudre rivers have their source in the Medicine Bow range of the Rocky mountains, in the neighborhood of Clark's and Cameron's peaks. These peaks rise some thirteen thousand feet above sea-level, and are never entirely devoid of snow; and, when the warm rays of the spring-time sun begin to beat upon their rugged sides, the snow and ice melt and fill all the streams with rushing torrents. The Big Laramie flows northward into Wyoming, where irrigation is not so far developed as in Colorado; consequently

its waters have not all been appropriated. The engineers found that, by intercepting one of its upper tributaries at an altitude of 9,500 feet above sea-level, quite a generous flow of this unappropriated water could be conducted, by the construction of a ditch around the steep sides of Clark's peak, and turned into Chambers lake, a tributary of the Cache la Poudre. Many difficulties, however, were encountered in the construction of this alpine canal. In the first place, the seasons are short in that altitude, and the work of construction could not be continued longer than the first of December, on account of cold weather, the snow falling at frequent intervals, and the ground freezing so that excavation could not be prosecuted. Again, the ditch must needs be constructed in many places along the steep side of the mountain, where the entire work was liable to slide out, or the ditch be filled with *débris* from a landslide from above. In other places it must be built through heavy timber; in others still through hard rock. At one point it was found necessary to tunnel for a distance of one hundred feet through solid rock, and at another point a flume four hundred feet in length carried the ditch across a deep depression in the mountain-side. For a great distance it was found necessary to build log curbing to sustain the outer bank of the ditch and to prevent its sliding down the mountain side." A ditch five miles in length, ten feet in width on the bottom, and from twelve to fifteen feet in width on top, is now in successful operation. At its upper end, its capacity is 242 cubic feet of water per second, and at the lower end 400 cubic feet. The increase in the capacity from the beginning to the end of the ditch is to accommodate the inflow of various small mountain streams. "The ditch is in charge of a superintendent and a crew of men for nine months in the year, —that is, from March until December,— and is patrolled daily and watched with the greatest care; for a leak might cause a break, and a break might carry out hundreds of cubic yards of earth work and make the ditch practically useless for days and days in the most critical season. During the summer months heavy showers of rain and cloud-bursts are frequent in these high altitudes, when water comes pouring down the mountain-side in tons. To obviate the danger of a break on account of a flood of water an automatic wasteway was invented. This is so arranged that water rising beyond a certain depth in the ditch lifts the waste-gate and relieves the strain on the banks of the ditch." There are connected with this ditch six storage reservoirs with a capacity of more than 600,000,000 cubic feet. This ditch supplies water for the Laramie county ditch, 71 miles in length, 20 feet wide at the bottom, and 30 feet wide at the top, which, constructed at a cost of $200,000, waters 30,000 acres of land. This ditch is connected with six storage reservoirs having a combined capacity of more than 600,000,000 cubic feet.

Steamships of 1862 Contrasted with Those of 1897.

UNDER the title, "The Place of Our Destination," the first part of a serial article by Professor John E. Sweet, in *American Machinist* (June 17), makes a comparison between steamships in the year 1862 and those of the most modern type. A vein of humor pervades Professor Sweet's articles, which adds much to the interest of all that he writes. He is well known as a keen observer in all matters mechanical. He describes a voyage made by him in 1862 from Boston to Philadelphia on the Cunard steamer America, and another made this year on the Lucania. The America will be well-remembered by many now living, but Professor Sweet gives some details of its dimensions which it is interesting to recall. "She was a wooden side-wheel steamer of, perhaps, 280 feet in length, from 2,000 to 2,500 tons' burden, with what were called side-beam engines, —that is, a vertical cylinder with its piston-rod connected to a crosshead above, connecting rods or links reaching down each side of the cylinder to the ends of two side levers, and from the other end of the beams a connecting rod reaching up to the drag-link cranks on the shafts; each shaft extending out to its own

paddle-wheel." The paddle-wheel ocean steamers have disappeared, and have been so long out of use that even those who can well recall them have almost forgotten their former existence. The comparison made between the old America and the modern Lucania shows enormous progress. The Lucania "is a double-screw iron steamer, 620 feet long, 62 feet wide, about 13,000 tons' burden, with two pairs of triple-expansion engines of 15,000 h. p. each." Not only the difference in size, but the difference in construction and sailing, is notable. Professor Sweet says that the two journeys were made in very similar weather, and under very similar conditions of the sea. The America pitched badly; the Lucania does not pitch at all, but rolls considerably. Professor Sweet says she rolls most in a smooth sea,—"a condition there is certainly no excuse for; for to prevent it is a simple mechanical problem, much less intricate than others in the same line." Professor Sweet humorously tells of the sea-sickness suffered on the old America, which has been replaced by *mal de mer* on more modern ships. "I well remember when my chum suggested a pint of sea-water as a remedy. I said I thought a point of land would suit me much better. He seemed to think it very funny; so one can see there has been a change in wit as well as in ships, for what was laughable then seems now as flat as a surface plate." An interesting point in the history of screw propulsion is noted as follows: "In the early days of screw propulsion, the most difficult thing they had to contend against was the governing of the engines, and during a trip in March, 1865, in the screw steamer City of New York, No. 2, no attempt—or at least no successful attempt—was made to govern the engine; as the ship pitches fearfully, the engines went like a wind-mill when the screws came out of the water, and slowed down to a quarter speed when wallowing deep in the sea. Suggestions were then made that the proper source to govern from was wells or chambers in the stern of the ship, and this means is now adopted. This system has been worked out so perfectly, that the Lucania is now perfectly governed in a rough sea; she will not race nor lose in such a sea over two knots out of twenty-two. The principle of the governor is simple. When the stern of the ship comes out of the water, the pressure in the chambers is reduced and the throttle closed; when the stern goes down, the pressure is increased and the throttle opened. The preventing of the ship's rolling in a smooth sea is not a more difficult, though a different, problem. When one stops to think what an insignificant thing a rudder is, and what it does under the worst of conditions, why should he question the efficacy of a rudder in the keel of a vessel to keep it from rolling? As the steersman guides his rudder by the compass, so, too, would the leveler guide his rudder (or fins—as would have to be used in a ship like the Lucania, which has no keel) by a level or plumb. It might not prove impossible to work the device automatically, but any attempt to hold the ship on an even keel would not do. The ship's natural position when careened by load or wind would have to be found; or, in other words, the thing desired would be to hold the ship as near as possible at a mean between its natural oscillations." Mr. Sweet's voyage in the America in 1862 was made in a little more than twelve days. The trip in the Lucania from New York to Liverpool required only a little more than six days. Neither the "pint of sea water" or the "point of land" was required in the latter voyage, as Professor Sweet declares himself to have been able to do duty in the dining-saloon three times a day.

Tall Office-Buildings.

IN a series of popular articles in *Scribner's* ("The Conduct of Great Businesses"), different writers have been endeavoring to display the characteristic features of some of the leading commercial occupations and enterprises of modern times. The fifth of the series (May number) deals with the modern high building, which, "whether it be ugly or beautiful, whether it express pleasant or disagreeable traits and truths, is distinctively of this day and this country, and, containing all the other modes of en-

terprise, is comprehensively typical." It is regarded as a necessity from which there is no escape. Business men, finding that their business had outgrown their buildings, and unable to secure additional room on adjoining lots, were confronted with the alternatives of restricting the growth of their enterprises, of removal, or of starting branch establishments at more or less different locations. A large number preferred to retain the existing site and keep their business under a single roof; this could be done only by going skyward. The passenger-elevator, enabling a tenth or twelfth story to be reached as easily as the second or third, removed all physical difficulty, while architects and engineers, perceiving the situation and realizing all its demands, found themselves in possession of ample resources for carrying out the construction of buildings twenty stories high or more, if required. "The prices charged for a given space in one of the early buildings called high in New York will show how speculative, and how far astray, were the first reckonings on the effect of the elevator. The building was finished in 1868, and the manager let a suite on the top floor for $850 a year. He raised the rent the next year to $1,250, and, thinking the limit reached in that figure, signed a contract for a five-year lease. Bound by his agreement, he had to refuse offers rising gradually to $4,500, which he got readily at the end of the sixth year. People became accustomed to the elevator, as their fathers did to the steam cars, and now the top stories of high buildings bring in more rent than the middle floors." The financial aspect of tall buildings has invited capital, and, investments in this class of building having proved profitable, there is at present no abatement in the favor with which it is regarded. A business phase of the enormous value that can thus be placed on a comparatively small plot of ground is beginning to develop itself. "In most of our greater cities a man can borrow money at nearly as low a rate on real estate in the financial centers as he can on high-class bonds, and the difference is disappearing. The bonds have the advantage of their divisibility; the holder of a million dollars' worth can hypothecate them in any number of parcels at even rates, while the owner of a piece of real-estate of equal value has to put a mortgage on the whole to secure a loan, however small, and the first lien lowers the value of all subsequent mortgages. To obviate this difficulty, companies are incorporating to fund real estate, so that its value can be handled in the form of stocks and bonds, just as the securities of railroads and manufacturing companies are handled in the financial market." There is a tendency apparent to make tall buildings serve as residences for bachelor tenants, as well as for offices; and a restaurant has long been a feature of some great office-buildings. The future may see great hotels in which business men will reside as well as conduct their business, and which will supply not only food and lodging, but even amusement.

Excessive Rainfalls.

THE determination of the maximum quantity of water precipitated in any given time is one of the most important data sought by engineers when called upon to design a sewer and drainage system in any locality. If excessive demands for drainage are not provided for in advance, there is certain to be trouble, for which the designer will be held responsible. Mr. Alfred J. Henry, in the *Engineering News*, (June 24), calls attention to the fact that, in some of the heavy storms of the past year, many central cities have found their facilities inadequate for the discharge of the precipitated water, and damage to property and litigation have resulted from these failures. In view of the importance of the subject, Mr. Henry now makes what he thinks is "a first attempt to draw some useful deductions from the records of automatic rain-gages in use at weather-bureau stations," and has prepared a "table showing the accumulated amounts of precipitation for each five minutes during all storms in 1896 in which the rates equalled or exceeded one inch per hour at all stations of the weather bureau furnished with self-registering rain-gages." He has also tabulated for the cities of Washington, Savannah, and Saint Louis the percentage

of cases wherein the maximum intensity of rainfalls occurred within from five to sixty minutes from the beginning of the storm. The author suggests that, "if we select from the whole number of individual storms those shorter periods during which a very high rate was maintained, and plot the rates per hour as abscissæ in a system of rectilinear coördinates, we obtain, after connecting the points so plotted, a curve of probable maximum intensity." The records justify the division of excessive rains into two broad classes,—" (*a*) rains of great intensity and short duration and (*b*) of light intensity and long duration. Of these two classes, those of the first are by far the most damaging and destructive. In extreme cases, ninety-five per cent. of the downpour may quickly find its way into natural or artificial drainage channels. A rainfall of one-half inch in linear depth represents about 11,312 imperial gallons per acre. Assuming that in extreme cases only five per cent. is absorbed, it is easily seen how great a quantity of water must flow into the drainage channels." Conditions for sudden condensation and precipitation of water vapor are " (1) a strong vertical temperature gradient; (2) high surface temperature and humidity,—in fact, the general conditions of humidity and instability of the atmosphere necessary to the formation of thunder-storms and tornadoes." Of the first class, the cloud-bursts of the mountainous and arid regions of the west are the most violent. These cloud-bursts may occur in any of the "mountainous localities throughout the entire territory bounded by the British possessions on the north and the Mexican border on the south, the foot hills of the Rockies on the east and the sierras on the west." While the downpour of water is extremely violent in this class of storms, it usually covers only a small area. The amount of water which falls in a short time is often surprising. An instance is given of a rain-fall of 8.8 inches in a single hour. Another case where 11.5 inches fell within an hour is named. It is evident that the records of the weather bureau can be made available for the supply of needed engineering data.

Electrolytic Precipitation of Gold from Cyanid Solutions.

THE *Mining and Scientific Press* credits to the *Transactions of the Chemical and Metallurgical Society of Johannesburg* the translation of a paper read by L. Ehrmann, wherein the simplification of the electrolytic process of precipitating coal from cyanid solutions is described. Professor Ehrmann states that the extraction of coal from cyanid solutions has assumed an importance that renders it nearly a capital subject of communications to the society named. "The zinc process has been in great favor on account of its simplicity, and very successful in general practice; but there are cases when either it is to be considered too slow, or the percentage of gold extracted from the solution too low. This is the reason why, principally with poor solutions, the electrolytic processes are used, when the simpler method of zinc boxes seems ineffective." He holds that the electrolytic processes are the best because they can be regulated, but they exact more care and technical knowledge than the ordinary zinc process. He lays down the principle that electrolysis of the solution produced in the zinc boxes by the contact of two different metals, instead of being produced by an external source of electricity, simplifies the electric process. He calls attention to the fact that elevation of the temperature, which facilitates the chemical reactions, and makes them more complete and rapid is a neglected question. His paper deals principally with the results of experiments which he has made in this way. In some cases zinc shavings were used in the ordinary way; in other cases they have been more or less coated with a very thin film of copper. The solution generally giving the best results was an ammonia cupric, cheaper and more effective than tartrate or other organic solutions. In reply to a question, Mr. Ehrman stated that the zinc he experimented with was the ordinary zinc obtained in Johannesburg. He would not make the experiments with pure zinc, because he wanted to experiment from a practical point of view. The method of experiment is dealt with at length, with

tabulated statements of results. The results of all the experiments are favorable to the action of the zinc-copper couple and hot treatment, showing that hot treatment precipitates as much gold in two hours as cold treatment does in twenty-four hours. The difference in results obtained with hot solutions was confirmed by some of the members present, although the amount of difference claimed by Professor Ehrmann does not appear to have been reached by the other experimenters.

The Present Standing of the Steel Truck.

THE gradual substitution of metal for wood in various kinds of construction is a feature of the age. Although wood ties are still so widely used in American permanent way that their possible future is scarcely ever considered by the general public, railway men have long been weighing their merits and demerits as developed in patented inventions and such designs as have been put to practical tests. In car-building any observer might have seen that metal trucks for freight cars have been supplanting wood. In the *Railroad Gazette* (June 4) the present standing of the steel truck is editorially discussed, while steel underframing for freight cars is the burden of an editorial in *The Railway and Engineering Review*, noticed below. The fact that this increase in the substitution of metal for wood has become a familiar topic in publications devoted to railroad affairs and interests is a plain indication of the trend of progress. The *Railroad Gazette* says that, "among men of inventive mind and men looking about for new fields, the design of a successful steel truck is looked on as one of the big prizes still possible in railroad engineering." Since the completion of the first Fox truck in the early spring of 1891, new designs have appeared each year, and our contemporary notes that the last year has been probably more prolific in this line of advance than the five years preceding it. The lay reader might perhaps infer from the remark relating to the completion of the Fox truck in 1891 that metal trucks are a more recent invention than they really are. But a continuous frame iron truck has been in use on the Boston & Albany Railroad for thirty years. The *Railroad Gazette* quotes a permanent official of that road in high praise of this truck as a mechanical structure. A metal truck costs more than the old style of truck, but, when well designed, is "practically indestructible except by wreck," and the cost of current repairs is very much less.

Steel Underframing.

THE *Railway and Engineering Review* (June, 1890) prints under this heading the report of a committee, submitted at the Master Car Builders' Convention. This committee of five, appointed to prepare individual designs for steel underframing, found, after considering the subject in two meetings, that some degree of uniformity in general dimensions is advisable. In order to secure an expression of opinion upon the most desirable inside dimensions and width of door for a standard 60,000-pound capacity interchange box car, a circular letter of inquiry was addressed to all the leading railways requesting information. Answers were received from most of them. Private car lines were not consulted, because their cars are mostly special, and their dimensions might not be desirable for general use in interchange service. The result of the inquiry was the choice of the following dimensions,—to wit, (*a*) inside length for standard box car, 60,000 pounds' capacity, 34 feet; (*b*) width, 8 feet 4 inches; (*c*) height from the top of floor to the top of the plate, 7 feet 6 inches; (*d*) width of side door, 5 feet 4 inches; (*e*) width of end doors (when end doors are used), 24 inches; (*f*) height of end doors, 36 inches; (*g*) height from the top of the rail to the top of the floor, 4 feet two inches. The report says: "The design should show the end still flush, and not projecting beyond the siding." A very careful consideration of practical points, both mechanical and commercial, was given to the subject, in working out the designs. These designs are printed, with descriptive text, as part of the report.

THE BRITISH PRESS

Day Loads for Central Stations.

OBVIOUSLY the earning of maximum profit by a power plant of any kind depends upon its running at its maximum rate of output for the maximum fraction of a solar day. The maximum fraction of the day will depend, of course, upon the conditions of working. Electric-lighting stations are handicapped by the fact that they can run at the maximum output for only a very small fraction of the twenty-four hours of a solar day. At a convention of the Canadian Electrical Association, the proceedings of which are published in the June number of the *Canadian Electrical News*, Mr. J. A. Kammerer discusses the ruinous effects of many of the old business methods of central-station managers, and notes the fact that the energies of these managers are now being directed "to retrieve what has been lost in the past in this respect." Not only are they completely reconstructing or rearranging their plants, but they are giving attention to the study of efficiency as a matter of the first importance to successful working. They are also seeking other means of procuring remunerative returns, and, as increase of rates cannot be looked for, they are reaching out for additional income. "Such additional revenue must be obtained from increased and prolonged use of current, to obtain which means of having current used for other purposes than illumination must be found, and consequently use in the day-time, or a 'day load,' as it is called, must be secured." Mr. Kammerer combats the claim that, because the business of electric-lighting companies is night work, they should not look for a day load, although he admits that this, "at the first blush, looks reasonable;" but he adds, "were the margins on the woolen mills or other commodities as small as they are in most of our cities and towns on electric lighting, the woolen mill would either have to close up, or make its plant investment work day and night to make ends meet." A central station used for lighting only has a maximum load for scarcely two hours out of the twenty-four. "Its maximum investment is, therefore, only exerting its full earning power for less than two hours instead of ten or twelve hours daily." Of course, fixed charges run for the entire time, as much when the plant is working at a minimum rate as when it is producing its maximum amount. Mr. Kammerer shows that the multiphase alternating system, which permits of the supply of power as well as light, meets the ordinary situation at the present time, and he advises the cultivation of a day-lighting service among merchants, etc., there being many situations wherein an artificial light would be of use during the day as well as at night. As to industries to which power can be supplied during the day by the multiphase lighting current system, there seems to be no lack. There is the butcher with his meat-chopping machine, the baker with his dough mixer, the newspaper with its printing press, the foundry with its line of shafting to drive, and the planing mill with its machinery to be kept going throughout the day, in every town, while other and larger industries will be attracted to a town in which a day power service may be obtained. These different industries, all using power during the daytime, tend to create a steady load line, which is especially desirable, as it increases the number of hours in which the investment is exercising its earning power, and helps to increase and secure the maximum load line throughout the twenty-four hours.

Wood Pavements and Sanitation.

ON account of the porous and absorptive character of the material, its proneness to decay when exposed to atmospheric influences, its softness, and the failures which attended the earlier experiments in wood paving, this class of road surfaces fell into disrepute in America. On the other hand, in Paris, where asphalt paving has become highly popular, the failure of the initial experiments in wood paving has not discouraged further effort, and that city has to-day

a surface of 540,000 square meters of wood paving, so well liked that, not only in the French capital, but in provincial cities, the demand for it is constantly increasing. *The Sanitary Record* (June 11) discusses this subject from the standpoint that "the model roadway is that which commands cleanliness and dryness. A scavengered street, with well-flushed kennels, is never an unhealthy street." If the road be properly bevelled, the surface water is thrown off on either side, pools cannot form, and breeding-places and refuges for disease-spores are not created. The engineering requirements of a good roadway are that it must not be too rough or too smooth; horses must be secured a grip—a surety of footing. This will explain the disadvantages of asphaltum when in a "buttery" or greasy condition, and why hardness in wood is not in itself a recommendation. "A good road ought to produce from wear and tear but little detritus. Judge of what the latter can be, when the Seine, in 1879, annually received no less than 330,000 cubic yards of Paris street mud. The pavement was then in granite, whinstone, and porphyry, in addition to macadam surfaces. It is calculated that the total space between the joints of paving-stones equals one-third of the set-stone area. In some of the leading Paris thoroughfares corresponding with the main sewers the latter are provided with perforated iron catch-baskets, into which the street water with its charged sediment falls. The latter is retained and duly extracted. Wood pavement does not suit all kinds of traffic, or roads of steep grades. However, in Paris, immense trucks, drawn by five or seven horses, and transporting solid ready-dressed blocks of building-stone of seven to ten tons in weight, pass without injuring in the least the wood-paved streets." These wooden roads are made in a very thorough manner, and it is upon this thorough workmanship that their sanitary excellence almost wholly depends. An indestructible water-proof foundation or bed of best Portland cement concrete, covered over with a coat of liquid mortar, is provided, and allowed to dry sufficiently before the wood blocks (Swedish pine) are laid down. This wood is naturally very resinous, and therefore resists atmospheric agents. It is also said to be very elastic, and so homogeneous that it wears very evenly. Its hardness is sufficient for durability, but not so great as to make the roads slippery. "The borders or kennels have the blocks laid longitudinally, but the joints are not filled in, in order to allow for the wood swelling or dilating. But the interstices of the blocks composing the road proper are filled in with a liquid mortar. The surface is next covered with a special gravel, prepared from broken porphyry, which easily penetrates into the tissue of the wood, forming a kind of indurated and impervious topcoat." This topcoat renders the pavements much less slippery than it would be without it. Such a pavement will last for from eight to ten years, and the price named for it in Paris ranges from twelve to sixteen francs per square meter. The pitch pine of Florida is said to be excellent, but is dearer than the Swedish pine. The blocks are not laid down in their natural state, but are first creosoted, after having been divided into three different qualities. The creosoting is done by the municipality, which has a factory that turns out 13,000 blocks daily. This number of blocks is sufficient to pave 300 square meters. The cost of repairs for such a road is named as two francs, while that for stone is only one franc. A very great deal of attention is paid to the cleanliness of the streets in Paris, and from this, doubtless, the sanitary repute of the wood roads has gained very much. While the wood roads are more costly, they are regarded as a luxury.

Transmission of Power.

TRANSMISSION of power should not be confused with transmission of energy, yet such confusion is often manifested by writers upon mechanical subjects. Such confusion can even be detected in an article under the above title in *The Engineer* (London, June 4). A trolley wire conveys energy, not power, from the power house to the motor of an electric car. The energy

thus conveyed performs no work, except in overcoming the resistance of the wire, till it reaches the motor, wherein it is converted into power, which is expended in the performance of work. The boiler of a locomotive does not transmit power from the furnace to the water in the boiler; it transmits that form of energy known as heat; strictly speaking, the boiler does no work. By a figure of speech, we say a boiler "works well, or ill," as the case may be; but, when we consult our mechanical and thermodynamical definitions, we find no warrant for saying that a boiler works, or that it transmits power; what it transmits is energy—a very different thing from either power or work. The steam pipe leading from the boiler to the steam chest of an engine cylinder does not transmit power; it simply transmits the heat energy generated in the boiler; only when the steam reaches the cylinder and the piston moves, energy is converted into work, which, when quantitively expressed in units of work performed in a specified time, is power. On the other hand, rope transmission, bell transmission, shaft transmission, etc., are examples of power transmission. The article referred to in *The Engineer* criticises the lack of judicial spirit with which the members of the Institution of Civil Engineers recently debated this subject. If some percentage of energy be required at a distance, derived from a primary source of energy, and if to get that distant energy as a derivative from the primary, mechanical power be transmitted between the two points, there will be required two conversions; first, energy must be converted into mechanical power, and, second, this mechanical power must be, in its turn, converted into energy. If, on the other hand, mechanical power be desired to be produced at a distance from some primary source of power, and to gain that power at a distance energy be transmitted, there will again be two conversions,—to wit, power into energy, and energy into power. If we are to agree in thought, we must agree upon the symbols of language used to express thought. The most rancorous historical debates and disagreements have been the offspring of mutual misunderstanding. In the debate reviewed editorially in *The Engineer*, it is true, the remarks were mostly confined to practical topics, but in this age it is so impossible to divorce practice from theory that, if one is confused in his theory, he is almost certain to be somewhat wrong in his practice. One reason for disagreement at the meeting referred to appears to have been the short time (ten minutes) to which each member was limited in his remarks. Such a limit in debating a subject so large in every way might well breed an impatience not provocative of good temper. This debate, as reported, is, however, full of interest to mechanical and electrical engineers.

Precautions Against, and Recovery After, Explosions in Coal Mines.

An attempt to codify a set of rules to be observed by owners and managers, and by men working in coal mines,—rules calculated to prevent explosions so far as precautionary measures can avail for such a purpose, to mitigate the dangers to which the men are exposed and the damage to mines and machinery resulting from explosions, and to facilitate the recovery of, first, the living, and, second, those killed in explosions,—is made in a very able and comprehensive paper by Mr. Garforth, read before the Confederated Institution of Mining Engineers, last June. Mr. Garforth expressed surprise that, considering the full and detailed accounts which have been written during the last century by experienced and scientific men to explain the cause of colliery explosions, and to suggest precautions for their prevention, the colliery men do not to-day possess a code of rules for practical use in a time of great excitement and confusion, such as usually follows a colliery explosion. He thought that, "if the manager had before him a form of rules and knowledge of the means which had proved successful at a neighboring colliery some years before, supplemented by information as to the mistakes committed at another colliery by which a second explosion and loss of life occurred, it would help to show him, at a critical moment, what to do and what to

guard against. It might also tend to reduce the feeling of helplessness more or less experienced when man is face to face with a calamity brought about by the forces of nature." The rules presented by Mr. Garforth are forty-two in number, and fill nearly three columns of the *Colliery Guardian* (June 11). Eighteen of these rules relate to precautionary measures, and the remainder to measures applicable after an explosion. They bear the unmistakable stamp of practical experience in coal-mining, and, as presented, they met with the general approval of the members, who, after the reading of the paper, engaged in an interesting discussion. Our readers must consult the article itself for the text of the rules. No attempt at an abstract would do them justice. The president of the association, Mr. Lindsay Wood, said that the suggestions in the paper would disseminate knowledge, the great safeguard for the prevention of accidents. He also suggested that the rules ought to be classified, the duties of the managers and owners being placed in one category, and those of the men in another. A member present remarked that these rules would impress upon the management the proper measures before the conditions arose, and he thought this a very important consideration. Some people think it sufficient to get the appliances when an accident has occurred, but this delay places them at great disadvantage. They would feel much more at ease if they had such possibilities constantly in mind, and had provided the precautions needed to meet them. He thought the rules ought to be printed and constantly exposed on the pit-heap or in the cabin for reference. Another member thought the rules should be embodied in questions included in the examinations for managers' certificates. These remarks sufficiently indicate the favor with which Mr. Garforth's paper was received, as well as its practical value.

Steam Pipes as a Cause of Fires.

FEW questions relating to the details of modern construction have elicited more discussion or given rise to more dispute than the assumed freedom of low-pressure steam pipes from the danger of igniting woodwork. While the direct ignition of new wood by the heat of low-pressure steam pipes may be regarded as impossible, investigation has proved, beyond a doubt, that the continuous action of temperatures, ranging from 212 to 225 degrees F., will produce in wood constantly exposed to the action of external air a condition wherein it will spontaneously ignite by absorption of oxygen. A number of fires in buildings have been attributed to this cause. The fact justifies the enforcement of the underwriters' rules for protecting woodwork near which steam pipes are placed, by covering it with metal plates, etc. Not only in buildings have fires thus been originated, but also in mines. In connection with the dangers attending the use of steam pipes in mines, the effects of steam upon wood are noted by Mr. A. L. Steavenson, in *Iron and Coal Trades' Review* (June 11). Reference is made by Mr. Steavenson to the experiments of M. Violette in a study of thermometric conditions or temperatures necessary to transform wood into charcoal. When wood has been thus carbonized, it becomes subject to spontaneous combustion due to the rapid absorption of oxygen, by which its temperature is elevated to the point of ignition. Indeed, it may be suspected that the absorption of other gases might also raise the temperature of such wood to the ignition point, which, if once reached, would be maintained by active combustion in the open air. M. Violette determined that, according to different methods of carbonization, he could obtain from fifteen to forty per cent. of charcoal, with marked differences in chemical and characteristic properties. At temperatures as high as 392 degrees F., he could not get good, black charcoal, but at 570 degrees the product was uniformly good. Other authorities have, however, determined that exposure of wood to a much lower temperature will produce results which M. Violette failed to secure, if sufficient time be given for slow action to take place. Professor Vivian B. Lewes says that, if coal be kept at a high temperature, but still far below its igniting

point, its ignition is simply a question of time, a temperature of 120 degrees being sufficient to create a dangerous risk. There seems to be no doubt that an analogous condition may be produced in wood, if kept constantly for a long period at a temperature considerably above the normal. Such wood becomes brown in color and friable, and seems to possess the power of absorbing oxygen, though in a less degree than charcoal. Of course at higher temperatures the danger is much increased. Examples are cited wherein wood has been discovered in a state of ignition while in actual contact with high-pressure steam pipes, and this contact was undoubtedly the cause of the burning. The practical application of Mr. Steavenson's paper to the precautions needed to guard against fires where steam heating is employed is obvious.

German Light Railways.

A DISPATCH to the British foreign office from Mr. W. S. Harris-Gastrell, commercial attaché to the British embassy in Berlin, contains a memorandum upon a movement for furthering a proposed extension of light railways in Germany, in which the State is desired to participate. An abstract of this memorandum printed in the *Board of Trade Journal* for June contains a brief history of light railways up to the present time, and gives the outline of a new bill now before the house of deputies for the extension of the State railway system and its participation in building storehouses for grain. This "Auxiliary Railway Proposal," as the bill is named, provides for (*a*) the expenditure of a sum of £2,970,800 on branch railways; (*b*) the construction of light railways for a sum of £400,000; (*c*) the erection of agricultural store-houses for grain, at a cost of £100,000. The choice of the new branch lines has been expressly governed by the consideration of bringing the light railways into connection with the main lines, in order to more thoroughly complete the railway system. The total expenditure contemplated is £3,470,800. Of the £2,970,800 which it is proposed to expend on branch railways, £299,400 are budgeted for working requisites and appliances, rolling-stock, etc. Mr. Gastrell says that "light railways ("Kleinbahnen") in Prussia are regulated by a law of July 28, 1892, which kept in view the special object of attracting private capital to this useful agricultural undertaking. The reports on these lines show that a considerable and rapid development has taken place by the aid of private capital, but, of course, only on those portions which promised fair returns on the money invested. This was not the case with those lines started merely with the object of developing adjoining lands. It was clear from the very beginning that it was possible to build such lines only with certain help. Hence the power given in the law on light railways to the provinces to allot part of their revenues for their furtherance. Although some provinces, such as Hanover and Westphalia, at once made extensive use of this power, it was not much employed elsewhere until State aid was given to these railways. By the law of April 8, 1895, £250,000 was granted for this purpose, and a further £400,000 was added thereto by the law of June 3, 1896. These sums were applied to create such light railways as were deemed necessary in the interest of the public, but which could not be built otherwise than with State aid." Up to 1897 the sum of £250,000 has been granted or promised in different forms of subsidy to railways having an aggregate length of about 625 miles. This appropriation of £650,000 will be fully absorbed by the new scheme, if it is carried out as proposed. The £100,000 allotted in the bill for subsidizing grain store-houses is additional to the $150,000 allotted by the law of June 3, 1896. The roads to which the allotments are to be distributed are specified in the memorandum.

A Remedy for Urban Overcrowding.

THE ever-increasing squalor of workingmen's homes in cities and large towns commands the pity of all philanthropists. Scheme after scheme for the amelioration of the conditions under which the majority of the earners of wages are compelled to pass their days has been brought for-

ward. Some of these have been tried with, at most, only partial success; the majority of those submitted to actual experiment have lamentably failed. The result is not encouraging for the success of new schemes, but, all the same, Mr. Stanley Boulter, in the *Illustrated Carpenter and Builder* (June 11), publishes a plan which, carried out, he thinks would brighten the lives of the British working class, and enable industrious workers to provide a real home for themselves and families. Incidentally, the encouragement of thrift and the influence of an effort to reach a higher plane of living, by saving, would, it is thought, do much toward elevating the moral status of the class which it is proposed to benefit. The chief characteristic of the scheme is the extension of the principle of the "Irish Land Purchase Act," passed by the Unionist party in 1885. Under this act a tenant may purchase his holding, the government providing the purchase money, to be repaid by the tenant in forty-nine yearly instalments. It is said that these yearly instalments for the most part represent an annual sum considerably less than the rent. An example is given of holdings at twelve years' purchase on the estate of Lord Shannon, where the rent was £20 a year and the purchase price was £240. This sum advanced by the government required the repayment of £10 per annum for a period of forty-nine years, at the expiration of which the purchaser would become the absolute owner of the property. Mr. Boulter has consulted with eminent authorities upon the values of real estate in the suburban districts of London, and is confirmed by these in his estimate that ten years' purchase of the gross rent is a reasonable price to place upon freehold workmen's dwellings. For a period of sixteen years, with interest at three per cent. per annum and what is considered a fair sum for parochial and water rates in addition, the weekly saving necessary to meet the annual payment would be, for forty-seven years, 4s. 7d., and, for sixteen years, 7s. 9d. These are extremes; we omit the figures for terms of years between. The repairs would, however, come upon the tenant, but most workingmen in mechanical vocations are competent to do for themselves the more ordinary repairs required for such cottages as would be provided. On this basis, Mr. Boulton proceeds to work out the details of the scheme, considering the topics of punctual payments, the character of the buildings to be erected,—for which he gives plans and elevation,—the removal of tenants, and provision for migration.

The Victoria Bridge over the River Dee.

THE various methods of constructing movable centers for bridges may be classified in three categories, according as the movable part swings horizontally, or vertically, or is moved longitudinally, to open a space for the passage of vessels. A bridge recently erected over the River Dee, described and illustrated in *Engineering* (June 11), comprises some rather unusual features in the construction of the movable center span. The bridge consists of three spans with two masonry abutments and two intermediate piers made of screw piles. There are ten 6-inch solid steel piles in each of the intermediate piers, fitted with Barber's patent mushroom screws, and driven from eighteen to twenty feet into the river bottom. The total length between the abutments is 397 feet. The fixed spans are each 140 feet long by 25 feet wide, carrying an 18-foot roadway and two paths each 3 feet 6 inches in width. They are constructed of steel lattice girders, attached to the screw-pile by riveted cap girders. These support a trough deck platform, with a roadway of concrete covered with asphalt and wood paving. The movable center-span made is in two halves, 160 feet long, which travel in and out of the fixed spans, meeting in the center of the river. The platform of each is deflected downwards a distance of 75 inches, so that it can pass under the platform of its correlated fixed span. Hydraulic rams and an arrangement of steel wire rope are employed to move the separate parts of the movable center, each being carried on six cast-iron flanged wheels placed under the girders. A pressure of 750 pounds per square inch is employed in

the rams, which are each 8 inches in diameter by 11 feet 6 inches in stroke. The rams are attached to the cross girders of the fixed spans. Vertical duplex steam pumps are employed to generate the pressure in the accumulators. The hydraulic machinery is in duplicate, so that the bridge cannot be crippled by the breaking down of the apparatus. The power house is situated near one of the abutments, and the water is carried across the stream in a pipe to the machinery of the opposite section. On account of a tidal phenomenon known as the "bore" in the River Dee, great difficulty has been encountered in keeping the pipes which convey this pressure in good working condition. At the turn of the tide this "bore" or wave is seen rushing up the river at a speed of four or five miles an hour, and, as the waters of the river are shallow, and the height of the wave varies from two feet to four feet, the scouring effect upon the river bottom is so great as to completely alter the character of the bed. This action has resulted in scouring out the bottom of the river under the transverse pipes, leaving them to a considerable extent unsupported. The pipes are thus so much strained as to cause them to leak. Much ingenuity has been expended in the effort to avoid this difficulty. Copper pipes of 1¼ inches in diameter, with screw unions, are now employed. An experiment is to be made with solid drawn lead pipes bound externally with copper wire. It is thought that this will give the required flexibility to meet the change in the condition of the river bottom. It seems to us that the electrical transmission of power across the stream would avoid the difficulty described, and would not cost as much as the pipes; but there may be reasons why this is impracticable.

Facts Pertaining to Wrought Iron and Mild Steel.

PROFESSOR A. Humboldt Sexton, in the *Practical Engineer* (June 18), says that these materials are nearly alike in chemical composition, both being very pure forms of iron containing not more than 0.5 per cent. of carbon; but they differ very much in their physical properties, as a result of different processes to which they are subjected. Wrought iron is produced from the common pig by the well-known process of "puddling," while one of the first steps in the production of mild steel is the melting of the crude material. Mild steel has come to the front, and has for many purposes completely superseded wrought iron, which once held the position of the only reliable metal for use in the constructive arts. The day of wrought iron is not over, however, for, although mild steel has taken its place for many purposes, the out-put of malleable iron in the Scotch works for 1876 was probably greater than that for any year since the commencement of the Scotch malleable iron industry. Iron or malleable steel may be made directly from the ore, and both of them have been so made in the past; but both are now prepared from the pig iron, which may therefore be considered as the crude material of both. The conversion of pig iron into either malleable iron or mild steel involves the removal of impurities, all of which, except sulphur and phosphorus, are more easily oxidizable than iron. Under suitable circumstances these may, therefore, be burned out. The puddling process differs very little at the present day from what it was when introduced by Cort. The methods of manufacture and the physical differences arising from differences in these methods are the principal topics dealt with in this article.

Railroad Bridges and Buildings.

IN the *Railway Magazine* for April is a general article by Mr. Walter G. Berg, which, under the above title, sets forth in an authoritative way the fact that this class of work has not escaped the specializing tendencies of the age. "The department of bridges and buildings of a railroad calls for a much greater special technical knowledge and practical training than is usually assumed by the general public and even by many railroad men, and, no doubt, far exceeding the expectations of the originators and pioneers of railroad construction." From this standpoint he summarizes in an

interesting way the nature of the work now employed in the department of bridges and buildings.

Secondary Minerals in Ore Bodies.

THE purpose of an article by E. Moriarty Weston in *The Australian Mining Standard* (March 18) is the stimulation of interest in observation and collection of facts pertaining to secondary minerals in ore bodies. The author, as far as possible, avoids theorizing upon the occurrence of the ore bodies themselves, and confines himself to the study of the secondary minerals as one of the most fascinating of subjects to mineralogists and geologists. Though the paper is necessarily technical in its treatment of these minerals, it also touches upon elements of popular interest. All the natural objects around us are undergoing chemical changes, although it is sometimes difficult to school ourselves into a full and constant realization of this fact. It is such changes that have produced the soils overlying the disintegrated rocks, and it is such changes to which the secondary minerals in ore bodies are ascribable. There is a striking analogy in the formation of some of these minerals to the formation of scale in steam boilers, the secondary formations in such cases being deposited from solutions. Such deposits take place often under slight changes in physical conditions, as is seen in the stalactites and stalagmites in caves. Minerals are often held in solution in water containing carbonic acid. The escape of this acid resulting from changes in temperature and pressure is often the cause of deposits of the material previously held in solution. Thus also gold may sometimes exist as a secondary mineral, as in quartz when it is seen to be surrounded by a greenish or red deposit of the sulphate or hydrated oxid of iron. The description of the chemical reactions through which gold thus occurs is too technical for our present consideration, but it, and the entire article, will interest students of mining and metallurgy.

Irrigation in the Northwest.

IN a very interesting and instructive paper read by Mr. William Pearce before the Association of Ontario Land Surveyors (*Canadian Engineer* for June), he states that few persons, if any, reared in a humid climate and afterwards residing in an arid or semi-arid one, where irrigation is needed, have not been impressed "with the neglected opportunities in irrigation in the humid portion." Even in the humid regions, irrigation is operated to a much greater extent than people residing in such regions are apt to appreciate; witness the almost daily watering of plants, shrubs, and trees by gardeners. The Dominion government instituted surveys in 1894, gaging streams and collecting data with reference to the amount of water available, such portions of the territories as are best adapted to irrigation, the location of sites for water storage, etc. The storage of water has a very important bearing on the conservation of forests. It is important that no time be lost in making the necessary reservations for storage in the settlement of new tracts, because the construction of roads and railways naturally occupies points most vital in storage of water at minimum cost. As an example, Mr. Pearce cites a report of the United States geological survey to the effect that at one point in the Rio Grande the creation of a reservoir at the best point would necessitate the reconstruction of a railway involving an outlay of hundreds of thousands of dollars.

THE FRENCH AND GERMAN PRESS

Recoil Pistols.

THE success of the Maxim automatic rapid-firing gun, in which the mechanism is operated by the force of the recoil, is well known. The same principle has now been applied to pistols, a very successful recoil pistol having been produced by the famous maker of small arms in Germany, Herr Mauser. The original idea of utilizing the force of the recoil is due to Bessemer, who suggested it as long ago as 1854, and the applications to disappearing gun carriages as well as to the Maxim gun have been long enough in use to demonstrate the value of the principle. The Mauser pistol, which was exhibited before the society of German engineers at Wurtenberg, is described in the *Zeitschrift des Vereines deutscher Ingenieure* for May 1, in which full details of its construction and operation are given. The general arrangement of the arm is that of the modern magazine guns, on a smaller scale, the principle differrence being in the sliding breech block and firing mechanism, the force of the recoil throwing the block back and at the same time compressing a long spiral spring, which returns it after the cartridge has been fed upward. So long as the trigger is drawn back, the firing continues, while, if the trigger be released, the weapon remains loaded and cocked, ready for action upon the next pull of the finger. The cartridges are fastened together in charges of ten, which can be very quickly loaded into the magazine. The pistol is also made for twenty cartridges at a loading. The rapidity of fire is, of course, the great point, and, it is stated, eighty shots a minute can be succesfully fired. No attempt is made to cool the barrel, as is done in the Maxim gun, but no ill effects appear from this omission. A ten-shot pistol of this type was fired 2,200 times as rapidiy as possible, without being cooled or cleaned, and operated perfectly without apparent injury, while no appreciable wear upon the parts was visible after 10,000 shots. The extent to which such a weapon will be found useful in actual warfare may be questioned, since the waste of ammunition in proportion to the execution is likely to be large, but, considered as a mechanical device, it is certainly a most ingenious production, and possibly may lead to another revision of the small arms of more than one nation, should the recoil principle be demonstrated of sufficient practical value to demand further extension.

Beton Tanks.

THE issue of the *Zeitschr. des Ver. deutscher Ingenieure* for March 13 contains an account of the new water works recently installed in the little town of Calbe, on the Saale. The plant is a small one, the supply being about 900,000 gallons per day, and the only point of especial interest is the tank in the water tower. This tank, which is about 34 feet in diameter by 20 feet deep, is of the Monier type of béton construction, the necessary tensile strength being obtained by imbedding in the wall of the tank a system of round iron rods 10 millimeters in diameter. The bottom of the tank is supported upon a béton dome resting on the masonry walls of the tower, and the whole construction has apparently proved satisfactory. The thickness of the tank walls is about eight inches at the bottom and four inches at the top, and, as the iron nowhere comes in contact with the water, injury from rusting, will it is expected, be avoided.

The Crystallization of Carbon.

THE experiments of Moissan, and his success in producing microscopic crystals of carbon which, technically at least, were entitled to be called artificial diamonds, are well known. We now have further contributions to the subject of the crystallization of carbon by the well-known electro-chemist, Dr. Borchers, who contributes an article to the *Zeitschrift für Elektrochemie* reviewing the past attempts in this direction and describing his own experiments. Moissan worked upon the line of crystallization of fused carbon under immense pressure, while Borchers

attains the same or similar results by maintaining a carbon rod at the high temperature of the electric furnace for considerable time, the surface of the rod showing distinct evidences of crystallization.

The experiments have been carried out upon a small scale only, and, being unable to continue the researches, Dr. Borchers gives a full account of his methods and apparatus, trusting that further investigations may be carried on by those who have powerful currents at their disposal, and opportunity to carry out all the conditions which success demands.

Deep Mine Shafts.

THE depth to which mining shafts have been sunk in various parts of the world is testimony to the industry with which man has constantly sought to win from the earth her mineral treasures, and the list here given, compiled from various sources, and taken from a recent issue of *Stahl und Eisen*, will be of interest.

Belgium:	
Produits mine, Mons,	3930 feet
Vivier shaft, Gilly,	3740 "
Viernoy shaft, Anderlues,	3300 "
Marchienne mine	3120 "
St. Andre shaft, Poirier mine, Charleroi,	3100 "
Germany:	
Kaiser Wilhelm II, Clausthal, Harz,	3020 "
Einigkeit, Lugau, Saxony,	2620 "
Samson, St. Andreasberg, Harz,	2560 "
Monopol mine, Camen, Westphalia,	2535 "
Frieden mine, Oelsnitz, Saxony,	2510 "
Concordia mine, " "	2415 "
Maria mine, Hongen, Rhine Province,	2296 "
Camphausen mine, Saarbrucken,	2299 "
France:	
Montchanin mine, Le Creuzot,	2296 "
Treuil mine, Saint Etienne,	2033 "
Hottinguer shaft, Epinac,	2000 "
Great Britain:	
Pendleton, Manchester,	3470 "
Ashton Moss, "	3350 "
Astley Pit, Dukinfield,	3150 "
Dolcoath mine, Cornwall,	2580 "
Rose Bridge shaft, Wigan,	2490 "
Norway:	
Kongsberg Silver shaft,	1900 "
Austro-Hungary:	
Adalbert, Przbram, Bohemia,	3570 "
Maria, " "	3281 "
Anna, " "	3100 "
Franz Josef " "	2900 "
South Africa:	
Robinson Deep, S. A. R.,	1995 "
Kimberley, Cape Colony,	1265 "
De Beers' mine,	1095 "
United States:	
Red Jacket, Calumet & Hecla, Lake Superior,	4890 "
Tamarack, Lake Superior,	4475 "
Yellow Jacket, Comstock, Nevada,	3120 "
California mine, Colorado,	2260 "
Grass Valley, Idaho,	2180 "
Victoria:	
Lansell's, Bendigo,	3300 "
Lazarus, "	3020 "
Magdala, Stawell,	2410 "

The Henrichenburg Canal Lift.

THE completion of the mechanical canal lift at Henrichenberg calls attention to the favor which this substitute for the old-fashioned lock system is gaining on the continent, and the improvements introduced into this latest installation may lead to its consideration for future use at available locations in the United States. At Henrichenburg, on the canal between Emden and Dortmund, there is a difference of level of more than fifty feet to be overcome, and for this purpose a single tank lift, capable of handling boats of six hundred tons, has been constructed. The great difference between this lift and the well-known hydraulic double lifts at Les Fontinettes in France and at La Louviere in Belgium lies in the fact that the weight of the boat and tank in the Henrichenburg lift is carried by a system of floats, thus avoiding all the difficulties and expense of the great hydraulic cylinders. Beneath the lower slip there are five large wells, each containing a hollow metal tank, or float, and on these floats, by means of lattice piers, the tank is sup-

ported. The depth of the wells is such that, when the tank is at the lower position, the floats are at the bottom, while, when the tank is at the upper level, the piers are just long enough still to keep the floats submerged. The displacement of the five floats being just equal to the weight of tank and its contained water, it is evident that the lift will remain balanced in any position, and the only additional power required is that to overcome friction. The rise and fall are produced by four screws carried on a suitable trestle work and operated by electric motors, and the details of the plan are well worked out. The tank into which the boats are floated and by which they are carried is 28 feet wide, 230 feet long, and 8 feet deep, and the floats by which it is supported are cylinders 27 feet in diameter and 34 feet long. Since a boat always displaces a volume of water equal to its own weight, the counterbalance is the same whether the tank contains a boat or is filled with water; after the balance is once obtained, no further care is necessary on that score. A full account of the work is given in *Schweizerische Bauzeitung* (May 1), with illustrations. A comparison of this plant with the hydraulic cylinder lifts above referred to shows several points of advantage. The hydraulic system involves the use of double tanks, as one is necessary to counterbalance the other, and although double service is gained thereby when two boats are ready at the same time; yet in practice one tank often travels empty, and, where the traffic does not warrant the capacity, yet it must be provided. The heavy strains on the great cylinders, and the careful fitting required, add much to the cost of construction, so that the floating lift can be constructed at much less expense. In point of service there is little or no difference, the time being about three minutes for a lift of fifty feet in either case.

Watertight Bulkheads.

MODERN vessels are supposed to be provided with water-tight bulkheads, dividing the entire vessel into such a number of compartments that at least two of them may be filled with water without causing the ship to sink. If this end is to be attained, it is necessary to consider not only the number of bulkheads, but their location, and this question is not always given the consideration which its importance deserves. In the issues of the *Zeitschr. d. Ver. deutscher Ingenieure* for May 29 and June 5, Herr Middendorf, director of the German Lloyds, discusses the whole subject in a most thorough manner, giving numerous diagrams showing the principles upon which the number and arrangement of the bulkheads should be based. Ever since the sinking of the Elbe, the importance of the question of the disposition of the compartments in vessels has been under investigation in Germany, and the present articles are the result of the theoretical and practical investigations which have been made. It is evident that the filling of compartments near either end of the vessel will disturb the equilibrium to a greater extent than if the leak occurs amidships, as in the former case the level position of the ship will be disturbed to a greater degree, and her seaworthiness proportionally impaired. For this reason it is desirable that the compartments forward and aft should be smaller—*i. e.* the bulkheads closer together—than they need to be in the middle of the vessel. The danger line is, of course, the level of the top of the bulkheads, as, if any pitching or rolling brings this line too low, adjoining compartments will fill, and further submergence result. By a combined analytical and graphical investigation, for which the reader must be referred to the original articles, Herr Middendorf constructs what is called a "bulkhead curve," being a diagram indicating for any given vessel the spacing of bulkheads which will cause only a known disturbance of the danger line for the filling of two adjoining compartments. This investigation assumes, in the first place, that all the compartments are empty of cargo, and that a leak will fill them entirely with water. A subsequent discussion takes into account the influence which the contents of the compartment may have upon the disturbance of equilibrium. When merchandise contained in

casks, or water-tight packages, is to be considered, the quantity of water which the compartment can contain is evidently limited to the space between the packages, while in the engine room the volume of the machinery may be deducted, and for other classes of merchandise proportional values have been computed. Upon these conditions the German Lloyds has formulated a series of rules for the placing of bulkheads which must be applied to vessels seeking its register, and it is believed that the strict observance of these conditions will conduce to the greatest safety with the least possible disturbance to comfort and convenience. The articles of Herr Middendorf should command the consideration of the shipping interests of other nations by reason of the importance of the question, while the scientific manner in which the complex problem has been handled cannot fail to interest engineers in any case.

Car-Heating in Germany.

THE use of steam for warming passenger cars has been under trial on the Prussian State Railways since 1887, and, with various modifications and improvements, it seems to have attained sufficient success to cause it to be considered a permanent method. At a recent meeting of the German Society of Mechanical Engineers, a paper describing the present system used in Prussia was read by Herr Wichert, and published in *Glaser's Annalen* for June 1, and from this we abstract some points of general interest. In the earlier installations, the steam was taken from the locomotive at a comparatively high pressure,—forty to fifty pounds,—and the water of condensation was returned in each car through the steam inlet pipe. This caused much trouble from the interference of the water with the steam, and in long trains there was also the objection that the forward cars were overheated in the effort to obtain sufficient warmth in the rear cars. The amount of warmth in various portions of the train was difficult to regulate, and there were various minor obstacles to be overcome. The improved system possesses two especial differences from the original method; the steam is used at a much lower pressure, and there are in each compartment several radiators of different amounts of heating surface, so that gradations of warmth can be obtained. The steam is delivered by one main, and the water of condensation discharged by another, and the steam from the main may be delivered to all, or to a portion, or to none of the radiating surface in any compartment, without in any way interfering with the circulation in the rest of the train. This permits the use of a regulating lever in each compartment, which may be operated by the passenger himself, a pointer indicating the direction of motion required to increase or decrease the temperature. The radiators are composed of U pipes lying flat under the seats, much the same as in the systems used in the United States, and the details possess no especial peculiarity. A special attendant rides on the train, and controls the general operation of the whole apparatus, it being his duty to have the carriages properly warmed before starting, and to inspect compartments which may have been vacated, to see if they have been left in proper condition as regards warmth. While many of the details of the Prussian system are only adapted for the European system of railway carriages, there are some points worthy of consideration in the United States, especially the idea of a variable quantity of heating surface in the radiators. A slight degree of warmth in spring and fall would often be most acceptable on our trains, when the full radiating surface would furnish an intolerable degree of heat, and there is no good reason why this should not be attainable in some such manner as in the Prussian system.

The Regulation of the Lower Danube.

WE reviewed in the March issue of the magazine the important and difficult work so successfully completed on the lower Danube, by which a continuous waterway has been made available for commerce, and we can now only call attention to a valuable illustrated paper upon the same

subject by the Hungarian councillor, Ernst Wallandt, presented before the general meeting of the Austrian Society of Architects and Engineers, and published in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for May 14 and 21. In addition to a description of the difficulties overcome, the paper contains topographical maps and profiles which enable the magnitude and character of the work to be very clearly understood. Illustrations are also given of the various dredges, submarine drills, floating cranes, etc., by means of which more than 225,000 cubic meters of rock were removed under the difficult rapids, not including the 360,000 cubic meters of excavation in the canal of the Iron Gates. Many interesting details of the submarine work are given in the article, which can be only very briefly noted here. The total length of obstructed river was about fifty-six miles, of which only brief portions were uninterrupted, and in most of this long stretch the rapidity of the current formed a serious impediment to the operations. The boats carrying the rock drills were each provided with four massive feet extending to the river bed, and, by means of powerful steam windlasses, the weight of the boat was thrown upon these as posts, thus relieving the drills from the motion due to the undulation of the water. Various forms of drills were tried, but the bulk of the work was done with the Ingersoll and the Lobnitz rock drills, the total number of holes up to the end of 1896 being about 50,000. Much of the work upon the Iron Gate Canal was done either in shallow water, or within coffer dams drained by centrifugal pumps. It is proposed to use chain towage, with fixed tow chains passing over pocketed chain wheels on the boats, for much of the traffic through the canals, this being especially adapted to contend with the rapid current.

Carbid of Iron.

IN a communication presented to the French Academy (*Comptes Rendus*, April 5) M. Henri Moissan gives the results of his recent experiments in the direct production of carbid of iron in the electric furnace. The operation forms an interesting sequel to the production of artificial diamonds, which, as is well known, M. Moissan produced, on a microscopic scale, several years ago. The principle involved in the production of the iron carbid is that enunciated by MM. Troost and Hautefeuille,—that ozone may be generated at temperatures of 1,300° to 1,400° C., notwithstanding the fact that, when produced at ordinary temperatures, it is readily destroyed by the least accession of heat. After describing in detail the method of experiment and the means employed for purification, M. Moissan sums up as follows: "When pure iron and carbon produced from sugar are raised to a high temperature in the electric furnace and slowly cooled, there is found a very small quantity of combined carbon in the metal. In this manner we may obtain a gray iron, solidifying at about 1,150° C. If the metal, at a temperature of 1,300° to 1,400° is poured into a mould, there is found, after cooling, graphite and a large proportion of combined carbon; this is white iron. Finally, if we cool in water suddenly, iron saturated with carbon at 3,000° C., there is produced in the metal an abundant crystallization, from which we may separate a pure and definitely-crystallized carbid of iron, corresponding to the formula $C\,Fe_3$. This carbid is identical with that found in steel. . . . These facts may all be explained simply by admitting that the carbid of iron, like ozone and oxid of silver, may be formed at a very high temperature, and then progressively decomposed by a diminution of temperature. Thus we find a considerable quantity in steel, of which the point of fusion is quite high; much less in white iron; and still less in gray iron."

Petroleum Motors.

THE demand for an economical and convenient motor, especially of moderate capacity, has been met by a number of makers of gas and petroleum motors in different parts of Europe; and in the notes from the expositions at Berlin and at Geneva, published in various journals, there are nnmerous descriptions of the latest forms.

Petroleum motors were especially in evidence, and the many designs of simple and convenient engines operated by the internal combustion of petroleum should furnish some impetus to this branch of mechanical engineering in the United States. A series of articles in the *Zeitschrift des Vereines deutscher Ingenieure*, reviewing the exhibits at Berlin and Geneva, gives especial prominence to the variety of petroleum motors there shown, and the simplicity of many of these little engines is noteworthy. The general principles of construction were practically the same in all, the petroleum being drawn in with the air in such a manner as to be not only sprayed, but vaporized by contact with heated surfaces of metal. The mixture of vaporized oil and air is then compressed in the same manner as the charge in a gas engine, and ignited by an incandescent tube. In one form of engine the oil is vaporized in a separate vessel, or gasifier, the heat being supplied by the exhaust gases from the cylinder, and the engine details being practically the same as in a gas engine; but in nearly all cases the oil is supplied and vaporized stroke by stroke. The greatest room for difference of design lies in the construction of the governing device, and the difficulty of obtaining close regulation is probably the principal defect. Although the principle in all the regulators is that of the omission of power strokes until the speed begins to fall, the means by which this is obtained vary, being in some cases a pendulum, and in others a centrifugal governor, sometimes cutting off the oil-supply, sometimes diverting it to a by-pass to be returned for use again. The economy of the engines differs mainly with the size, the larger engines naturally being more economical, and the consumption of petroleum varying from 0.85 pint per h. p. per hour for a 16-h. p. motor to 1.25 pint for a 4-h. p. motor. The efficiency of such engines depends upon several elements, not only the degree of compression and the temperature being involved, but also the perfection of the mixture of the air and combustible, the form and character of the compression space, and the position of the ignition tube, since, if these details are not well arranged, much of the combustible will be discharged unburned. The designs exhibited last year and very fully illustrated not only in the journal above noted, but also in the *Schweizerische Bauzeitung* and in the *Revue de Mécanique*, give the latest practice of the best continental builders, and should be examined thoroughly by American constructors.

Alterations in Manuscripts.

A NEW method of detecting alterations in documents has been devised by M. Bruylants, professor in the University of Louvain, and is described in a recent issue of the *Revue des Sciences*. It is based on the following principle: When a sheet of paper which has been sized and finished is moistened, and then exposed, after thorough drying, to the action of vapor of iodine, the portion which has been moistened assumes a violet tint, while the remaining portion of the surface appears a brownish yellow.

This principle may be used to produce a sympathetic writing, since if we write with water upon the surface of paper treated with ordinary size, the writing will appear in a violet color when the dry paper is exposed to the vapor of iodine. The pale violet upon a yellow ground becomes a deep blue on a pale blue surface, when the paper is again moistened, and the characters disappear altogether under the action of sulphurous acid. When a manuscript is suspected of having been fraudulently retouched or altered, the use of the vapor of iodine will often serve to reveal the nature and extent of the alterations. Those portions which have been rubbed will become brownish in tint, and, when a rubbed surface is moistened after exposure to the iodine, it takes a blue color, varying in intensity according to the duration of the exposure. The outline of the rubbed portions remains perfectly distinct after drying, being paler in tint than the rest of the surface. This action is evidently due to the removal of a portion of the starch contained in the size.

These reactions also appear upon paper which has been entirely moistened and

dried,—as in the case of a letter copied in a press,—but the indications are somewhat less distinct. The process will also reveal the existence of pencil marks erased by rubbing. Apart from any traces of plumbago which may have remained, the path of the pencil-point disturbs the surface of the paper, as would any blunt instrument, and, even when the rubbing has been so carefully performed that it has not removed any portion of the surface of the paper, the marks are made entirely legible when exposed to the iodine vapor. The clearness of all these reactions depends upon the character of the paper, and that which contains the smallest quantity of sizing material will naturally give the least brilliant effects; but in every case the changes above described will appear to a greater or less degree, and the use of the reagent in skilful hands should give material aid in clearing up disputed questions of this nature.

The Purification of Waste Water.

THE question of the pollution of streams by the discharge of waste water from manufacturing establishments is often an important one, both to the community and to the mill-owner, and the fairest solution is often uncertain. In a discussion of the subject in the *Oesterr. Monatschr. f. d. oeff. Baudienst* for May, it is shown that in most cases a simple purification installation, varying in character with the nature of the waste, is found sufficient, as a rule, to meet all the imperative requirements. In many instances sedimentation is all that is necessary, and a settling tank or pool of size proportioned to the magnitude of flow will remove the mechanical impurities. Where the work must proceed continuously, a pair of tanks should be provided, so that alternate cleaning may be done. In some cases disinfection or chemical clarification is necessary, and occasionally a filter plant is required. The author of the article referred to, Chief Engineer Skalda, of Brünn, in Austria, describes a simple form of purification plant used with success in connection with several breweries, sugar refineries, and other manufacturing establishments. The plant consists of a double set of basins, through each section of which the flow of impure water alternately passes. In each series there is first a settling basin of sufficient size to require about an hour for the passage of the flow, the current being guided by deflectors in such a manner as to disturb the settlings as little as possible. This is followed by a clearing basin, in which, by a small addition of milk of lime (0.0017 to 0.002 per cent.) mixed by passage through deflecting partitions, the turbidity is removed; and by a filter for the removal of final impurities.

In the plans shown, a space 70 feet long by 30 feet wide and 11 feet deep is required for a plant capable of treating 2,500 cubic feet of water per day, cleaning being required every 40 days; the water containing 2 per cent. of sedimentary matter. This is a double plant with sluices, enabling one-half to be thrown out of use at a time, to provide for cleaning without interruption.

Acetylene Residues.

WHEN acetylene gas is generated by the action of water upon calcium carbid, the residue is a hydrated lime which is usually thrown away, although it has been suggested that it be used in the manufacture of mortar. A note in the *Comptes Rendus* by M. Chuard, however, has indicated another use for this by-product. It is known that in the production of acetylene a small proportion of ammonia is also generated, and it is found that the production of ammonia continues after the generation of acetylene has ceased, if the mass is kept in a moist condition. It has been proposed, therefore, to use this mass as a fertilizer; M. Chuard finds also that, when applied to vines, it acts to prevent the development of the dread phylloxera. This he attributes to the presence of phosphuretted hydrogen, which, it is known, also appears in the generation of acetylene. M. Chuard even goes so far as to propose for this purpose the preparation of a carbid from lime containing phosphate, and slaking the carbid especially for the purpose of killing the insects; but this is yet to be considered as a practicable scheme.

Electric Train Lighting.

In the issue of *Glaser's Annalen* for May 15, there is an interesting paper before the German Railway Association, by Dr. Max Büttner, reviewing the progress made in lighting passenger carriages by electricity. The paper is to a certain extent a statement of the claims of electric lighting, as opposed to those of gas and especially of acetylene, these latter methods of illumination having recently been discussed before the association by Dr. Pintsch. Dr. Büttner makes no extravagant claims for electricity, but gives some valuable information as to the experience of a number of railways in various countries, from the earliest, on the Jura-Simplon road in Switzerland, to the present time. The principal batteries in use are those of the Electric Power Storage Company of London, and of the Hagan and the Tudor systems in Germany. The comparisons are made principally with gas lighting; with storage batteries the question of weight is considered as important. In this respect the storage battery shows an advantage, the gross weight of gas tanks of equal lighting efficiency being about 30 per cent. greater; it is needless to say that with gas a lighting efficiency equal to that of electricity is usually not furnished. In regard to the commercial touchstone of cost, Dr. Büttner gives some very interesting diagrams, showing the relative cost per lamp-hour (8 candle power) of electricity and gas. As might be expected, the cost varies with the number of hours per day in which light is used, the fixed charges preponderating for the shorter periods. The difference is much less than would be imagined, and is slightly in favor of electric lighting for the longer runs and of gas for the shorter hours. At an average period of four hours per day, the cost is about the same, being about 3½ pfennigs (0.84 cent) per lamp-hour, assuming that both electricity and gas furnish 8 standard candle power. A diagram showing a comparison between electricity and acetylene is also given, but, as the comparison is not for pure acetylene, but for a mixture of illuminating gas and acetylene, it is not of general interest. Dr. Büttner states that pure acetylene is undoubtedly superior in illuminating power to electricity, but at present he considers the cost too great. The paper is of especial interest in view of the extending use of electricity in different countries. This is especially the case in Switzerland, Sweden, Russia, and Denmark; and, in general, there seems to be a response to the demand for better train-lighting.

Liquefaction of Fluorine.

The success which has attended the more recent attempts to reduce the former so-called "fixed" gases to the liquid state is progressing steadily, and each success is utilized to assist in the next. MM. Moissan and Dewar have now announced in a note to the French Academy (*Comptes Rendus*, May 31) that they have succeeded in liquefying fluorine, this element having hitherto resisted all attempts. The liquefaction was effected very simply, without the use of pressure above the atmosphere, the agent being the intense cold produced by the evaporation of liquid oxygen. The temperature of liquefied oxygen is about —183° C., which is in itself not quite low enough to cause the fluorine to become liquid; but, when a vacuum was formed above the liquid oxygen, the rapid evaporation lowered the temperature, and the drops of liquid fluorine began to collect, at a temperature estimated to be —185° C. The product was a clear yellow liquid of great mobility, having no action upon glass; as soon as the temperature was permitted to rise, a rapid ebullition of fluorine gas given off. In connection with these experiments an interesting phenomenon was observed. When a current of fluorine gas was passed through liquid oxygen, a flocculent white deposit was formed, which settled at the bottom of the vessel. When this was separated by filtration, it was found to possess the curious property of deflagrating as soon as the temperature began to rise. Until now no compound of fluorine and oxygen has been known to exist.

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American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
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American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
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Architectural Review. *s-q.* $5. Boston.
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Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
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Fire Protection in Europe. Edwin O. Sachs. The first of a series of contributions intending to record the facts and issues, and furnish an outline of fire protection as it exists to-day. 6500 w. Engng—June 18, 1897. Serial. 1st part. No. 13709 A.

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Tests of the Wearing Qualities of Flooring Materials. A valuable series of tests to determine the relative durability of various flooring materials, with results, and valuable diagram. 600 w. Sci Am—July 3, 1897. No. 13769.

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LEICESTER.

The Architecture of Our Large Provincial Towns. Illustrated description of the structures in Leicester, with some historical matters of interest. 7500 w. Builder—June 5, 1897. No. 13399 A.

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The New University Library at Princeton. Andrew F. West. Illustrated description. 600 w. Harper's Wk—June 12, 1897. No 13339.

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The Mont Blanc Observatory. From *La Nature*. Brief illustrated description of an interesting construction. 1000 w. Sci Am Sup—June 12, 1897. No. 13373.

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The Royal Infirmary, Glasgow. A correspondent of the *Glasgow Herald* presents a scheme, considering the question in relation to its surroundings. 1600 w. Arch, Lond—June 11, 1897. No. 13638 A.

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Site, Construction and Furnishing of School-Houses. Excellent recommendations and regulations for "lighting, heating, ventilating and other sanitary arrangements" of school-houses, issued by the State Board of Health of Vermont. 1200 w. San—June, 1897. No. 13450 D.

STEEL-SKELETON Building.

The Architectural Relations of the Steel-Skeleton Building. F. H. Kimball. The problems confronted in the creation of a high building, and the order in which they must be studied. Ill. 3300 w. Eng Mag—July, 1897. No. 13808 B.

STRASBURG.
The Romanesque Style in Strasburg Cathedral. (Das Strasburger Münster Romanischen Stiles.) An account of the Romanesque details to be found in the earlier portions of Strasburg Cathedral, with plans of the structure at various dates. An interesting contribution to architectural history. 6000 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13529 D.

TEMPORARY Structures.
The Paris Fire and the Building of Temporary Structures. H. Heathcote Statham. Showing how official control and inspection should guard against fire. Ill. 3600 w. Eng Mag—July, 1897. No. 13804 B.

THEATRE.
The "Westen" Theatre in Berlin. (Das Theater des Westens in Berlin.) Illustrated description of this handsome new theatre in the fashionable quarter of Berlin. 1 Plate, 2000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13523 D.

HEATING AND VENTILATION.

AIR Ducts.
The Proper Location of Air Ducts. David B. Dick. From a paper on Ventilation, read before the Toronto San. Assn. Gives experiments made to test the temperature at various heights in rooms, and discusses the problem, concluding that the warm air should be admitted at the floor, and the outlet be at the ceiling. 1500 w. San Plumb—June 1, 1897. No. 13270.

BLOWING Fans.
Tests of Blowing Fans Under Different Conditions and of Different Makes. R. C. Carpenter. Read at semi-annual meeting of Am. Soc. of Heating and Ventilating Engs. A talk on investigations made at Cornell Univ., and the results. 4200 w. Heat & Ven—June 15, 1897. No. 13745.

CAR Heating.
See Railroad Affairs, Maintenance of Equipment.

EFFICIENCY.
Efficiency of Heating Systems as Affected by the Removal of Air from the Radiators and Consequent Reduction of Pressure. H. A. Joslin. Read at semi-annual meeting of Am. Soc. of Heating and Ventilating Engs. Data obtained from tests made upon plants. Also discussion. 2800 w. Heat & Ven—June 15, 1897. No. 13746.

ELECTRICAL Heating.
Construction of Electrical Heating Apparatus. R. Van Rensselaer Sill. Read at semi-annual meeting of the Am. Soc. of Heating and Ventilating Engs. The writer points out what he believes to be the mistakes in the construction of the electric heater and shows how they may be remedied. Also discussion. 1200 w. Heat & Ven—June 15, 1897. No. 13744.

FACTORY.
Heating and Ventilating a Five-story Factory. Illustrated detailed description of the system used in the White Dental Factory, Philadelphia, Pa. 1300 w. Eng Rec—June 19, 1897. No. 13499.

FURNACE Heating.
Furnace Heating. Advocates the hot-air furnace for heating church buildings. 1200 w. Dom Engng—June, 1897. No. 13442 C.

HOUSE Heating Boilers.
The Relation that Should Exist Between the Steam and Water Ratings of House Heating Boilers. A. C. Mott. Read at semi-annual meeting of the Am. Soc. of Heating and Ventilating Engs. A discussion of the subject with the aim of drawing out valuable discussion. 2000 w. Heat & Ven—June 15, 1897. No. 13743.

SANITATION.
See Plumbing and Gas Fitting.

SHOP Heating.
Heating of the Shops of the Westinghouse Machine Company. The exhaust steam from the engines is used to heat the building with a blower and duct system. Illustrated description. 1400 w. Eng Rec—June 26, 1897. No. 13737.

SIEGEL-COOPER Co.'s Store.
Heating and Ventilation of the Siegel-Cooper Co.'s "Big Store." Illustrated description. 1100 w. Heat & Ven—June 15, 1897. No. 13742.

SOCIETY Meeting.
Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers. An account of the first semi-annual meeting with president's address, abstracts of papers read, business, etc. 9000 w. Met Work—June 26, 1897. No. 13687.

STEAM Heating.
Circulation of Steam for Heating Purposes at or below the Pressure of the Atmosphere. Reginald Pelham Bolton. A study of the internal conditions of steam circulation and heating, with a statement of the requirements for effective steam heating systems. 4300 w. Dom Engng—June, 1897. No. 13443 C.

New York Steam Company's Plant. Brief illustrated description. 1200 w. Heat & Ven—June 15, 1897. No. 13741.

On Some Dangers Attending the Use of Steam Pipes. A. L. Steavenson. Considers thickness of steam pipes, the fact that they may be the cause of fire, water rams, &c. 2000 w. Ir & Coal Trds Rev—June 11, 1897. No. 13630 A.

Pipe Covering as an Investment. C. H. Lietze. Calculations of the loss from bare pipes, and of the percentage to be saved by covering. 1500 w. Heat & Ven—June 15, 1897. No. 13747.

WOODBRIDGE Building.
Heating and Lighting of the Woodbridge Building, New York city. Illustrated detailed descrip ion. 2000 w. Eng Rec—June 5, 1897. No. 13275.

LANDSCAPE GARDENING.

GARDENING Design.
Doing Too Much. Editorial commenting on the mistakes made through ignorance, and citing examples illustrating intelligent treatment. 1700 w. Gar & For—June 16, 1897. No. 13440.

PARKS.
The Park System of Greater Boston. Editorial

on information from the lately issued report of the Metropolitan Park Commission. 1100 w. Gar & For—June 23, 1897. No. 13645.

Natural Beauty in Urban Parks. Editorial on the restful and helpful effect upon city dwellers, of natural scenery; the duty to protect such places and keep them for the good of the people; and a protest against the erection of buildings in objectionable places in Bronx Park. 1300 w. Gar & For—June 30, 1897. No. 13774.

PLUMBING AND GASFITTING.

DRAINAGE.

Details in House Drainage and Plumbers' Work. J. Kemsley. Reports cases where inspection showed that lack of attention to details caused serious illness and much trouble. 1800 w. San Rec—May 28, 1897. Serial. 1st part. No. 13300 A.

GRAVITY.

The Law of Gravity in Plumbing Work. N. Y. P. Remarks on the effect of the laws of the universe, especially of gravity as related to plumbing. 1700 w. San Plumb—June 1, 1897. No. 13269.

MASTER Plumbers.

The National Association of Master Plumbers, U. S. A. Part first consists of introductory remarks and an account of the creation, constitution, progress, &c., of the association. 5500 w. San Plumb—June 15, 1897. No. 13441.

SANITATION.

Plumbing, Heating and Ventilating a Modern Residence. Illustrated description of many excellent features as carried out in a residence at Wilkes-Barre, Penna. 2800 w. Met Work—June 5, 1897. No. 13266.

Plumbing and Sanitary Work. S. S. Hellyer. Read before the Architectural Assn., London, Part first discusses improvements in valve-closets, water supply, service pipes, &c. 4800 w. Brit Arch—May 28, 1897. No. 13301 A.

MISCELLANY.

ACOUSTICS.

Photographing the Koenig Manometric Flames. (Photographie des Flammes de Koenig.) A description of the method used to obtain permanent records of acoustic phenomena. Acetylene was used in the manometric burner and the vibrations photographed. 1000 w. Comptes Rendus—April 12, 1897. No. 13551 D.

ARCHES.

Strains in Arches. Joseph Marshall. The first of three articles giving the writer's theory regarding "Thrusts and Strains in Arches." 1800 w. Br Build—June, 1897. Serial. 1st part. No. 13706 C.

BENDING Moment.

Bending Moment Due to Concentrated Loads. H. Szlapka. Mathematical demonstration of method used by the author. 500 w. Eng News—June 24, 1897. No. 13686.

BUILDING.

Building and Building Material During the Reign of Queen Victoria. A review of the transformations in building material which have marked the reign. 4300 w. Ill Car & Build—June 18, 1897. No. 13688 A.

CATHEDRAL.

St. Paul's Cathedral. Part first discusses the relation of bishops and other clerics to architects and the preparation of the site, with its difficulties. Ill. 2500 w. Arch, Lond—June 18, 1897. Serial. 1st part. No. 13708 A.

CHIMNEY.

Straightening a Leaning Chimney. O. L. E. Weber. Describes a case where the straightening was effected by sawing the mortar joints. 1300 w. Technic—1897. No. 13757 D.

CHURCHES.

The Position of Choir and Organ in Churches. A letter from the Bishop of Chester to the London *Times*, with editorial, giving many opinions of noted architects and organists. 4200 w. Arch, Lond—June 11, 1897. No. 13637 A.

COLLAPSE of Building.

Fatal Collapse of Part of a Cast-Iron Column Building in New York. Description, with illustrations, of the collapse of a five-story factory building, corner of 51st street and 12th ave., with editorial. 3900 w. Eng Rec—June 12, 1897. No. 13436.

The Failure of the Brown Soap Factory Building in New York City. Discusses the collapse of a portion of the building at 12th Ave. and 51st street, with illustrated description of the structure, and the possible causes of the failure. 3500 w. Eng News—June 17, 1897. No. 13486.

DERRICK.

A Compact Derrick for Skeleton Buildings. An illustrated description of a derrick used for over two years on both high and heavy iron erection. It has many advantages, is very light and quickly moved, raised and refastened and adjusted. 700 w. Eng Rec—June 5, 1897. No. 13274.

FOUNTAIN.

The Hercules Fountain at Augsburg. (Der Hercules Brunnen in Augsburg.) Description and illustration of the handsome fountain designed by Adrian de Vries and built in 1602. 1 Plate, 1500 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13522 D.

FREE Homes.

Free Homes for the People. Stanlev Boulter. A scheme by which English municipalities shall be empowered to advance to the working classes the necessary money to purchase their houses, and that the advances shall be repaid, by instalments, instead of rent. 6500 w. Ill Car & Build—June 11, 1897. No. 13642 A.

LADDERS.

See Mining and Metallurgy. Miscellany.

ROCK Cutting.

Rock-Cut Tombs, Temples and Habitations. Cyrus K. Porter. Interesting description of ancient architecture. 5800 w. Stone—June, 1897. No. 13475 C.

SUBURBAN Settlement.

"Homewood," A Model Suburban Settlement. E. R. L. Gould. Describes a scheme for providing pleasant homes for the working classes, giving many plans of the houses, illustrations of the architecture, and general information. 3000 w. Am Rev of Revs—July, 1897. No. 13797 C.

TERRA-COTTA.

Suggestions for the Manufacture of Hollow Building Blocks. Robert Kunstman. Consid-

ers the selection of raw material, preparing the clay, machinery for making the blocks, drying and burning, and general arrangement of the factory. Ill. 2200 w. Brick—June, 1897. No. 13268.

TRANSATLANTIC.

Transatlantic Notes. Arthur Lee. Interesting notes on architectural and related subjects. 2400 w. Stone—June, 1897. No. 13474 C.

CIVIL ENGINEERING.

BRIDGES.

ALPINE Roads.

Concerning Roads in the Tyrolese Alps, Executed, Projected, and Desired. (Ueber ausgeführte, projectirte, und wünschenswerthe Tiroler Alpenbahnen.) A detailed account of the existing roads, dealing mainly with costs and financial results, together with a similar discussion of proposed constructions. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—May 28, June 4, 1897. No. 13516 E.

ARCHES.

See same title under Architecture and Building, Miscellany.

BEAMS.

The Theory of Reinforced Béton Beams. (Zur Theorie der verstärkten Béton platte.) An elaborate mathematical and graphical discussion of the principles involved in the Monier system of concrete reinforced by metal. Two articles. 8000 w. Zeitchr d Oesterr Ing u Arch Ver—May 28 & June 4, 1897. No. 13517 E.

DEFLECTION.

Apparatus for Maxima and Minima Measurement of Deflections. (Mesure des Flèches, Appareil á Maxima et Minima.) Illustrating the standard apparatus for measuring and recording girder deflections as used by the department of *Ponts et Chaussées*. 2500 w. Le Génie Moderne—May 15, 1897. No. 13536 B.

EUROPEAN Bridges.

Esthetic Design in European Bridges. Robert Grimshaw. Illustrations and brief descriptions of some artistic work in this line. 1500 w. Eng News—June 17, 1897. No. 13485.

LATTICE Girders.

Wooden Lattice Bridges in Galicia. (Hölzerne Gitterbrücken in Galizien.) Mainly descriptive, showing some recent structures with spans from 80 to 145 feet. 1 Plate. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—June 4, 1897. No. 13519 B.

RIVER Bridge.

Construction of Little Calumet River Bridge. Benjamin Douglas. Description with elevation of abutments and pier. 3000 w. Technic—1897. No. 13758 D.

TESTS.

Tests of Bridge Details. D. Y. Dimon. Abstracted from a thesis prepared for the degree of C. E. in 1896. The details tested were sleeve nuts, loop floor beam hangers or stirrups, welded loop eyes such as are used on light counter rods, bent eyes as used for lateral connections. Results are given. 800 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13672 D.

VIADUCT.

See Street and Electric Railways.

VICTORIA Bridge.

The Victoria Bridge Over the River Dee. Detailed illustrations and views of this bridge at Queensferry, with description. 1700 w. Engng—June 11, 1897. No. 13609 A.

CANALS, RIVERS AND HARBORS.

CANAL Lift.

The Canal Lift at Henrichenburg. (Das Schiffshebewerk bei Henrichenburg.) A lift of over 50 feet for canal boats of 600 tons displacement, the weight being counter balanced by floats and the lifting effected by screws. 2000 w. Schweizerische Bauzeitung—May 1, 1897. No. 13533 B.

DANUBE.

Soundings in the Danube. (Sondierverfahren an der Donau.) An account of the soundings made near Kritzendorf, to determine the volume of discharge. The so-called "cross" method was used, with diagonal intersecting lines, the distances being determined by the Reichenbach telemeter. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13525 D.

The Regulation of the Lower Danube. (Die Regulirungsarbeiten an der unteren Donau und deren Resultate.) A fully illustrated account of the canalization of the Iron Gates and the other improvements which have made the lower Danube navigable. Two articles. 10000 w. Zeitscher d Oesterr Ing u Arch Ver—May 14 & 21, 1897. No. 13514 E.

FLOODS.

Construction of the Most Recent Flood-Prevention Works in Eastbourne. R. M. Gloyne. Abstract of paper read before the Incorporated Association of Municipal and County Engineers, England. Describes works being executed for the purpose of obviating the periodical flooding to which parts of the town have been subject in times of heavy rainfall. Discussion. 2500 w. Builder—June 12, 1897. No. 13636 A.

The Mississippi Flood of 1897. William Starling. Discusses the sources of the flood, the effect of the new levees upon the flood height, storms, channel erosion, strengthening the levees, breaking of the levees, &c., &c. Ill. 12800 w. Eng News—July 1, 1897. No. 13818.

HOOGHLY River.

The River Hooghly, M. B. The improvement of this river, on which stands the metropolis of India. 2500 w. Ind Engng—May 22, 1897. Serial. 1st part. No. 13644 D.

RHINE.

The Regulation of the Rhine. (Die Rhein-Regulierung.) An account of the proposed regulation of the Rhine at its discharge into the Lake of Constance in order to avoid the frequent overflows. The cost is estimated at over

$3,000,000. 4500 w. and topographical map. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13520 D.

SAULT ST. MARIE.
The Busiest Canal in the World. William V. Kibbee. Describing St. Mary's Falls canal. Ill. 2900 w. Eng Mag—July, 1897. No. 13812 B.

SEINE.
Dangers to Navigation at the Mouth of the Seine. (Les Dangers de la Navigation à l'Embouchure de la Seine.) Describing the shifting of the bar, and the variations in the channel, with suggestions as to the remedy; with hydrographic charts 1 plate 3000 w. La Revue Technique—May 10, 1897. No. 13540 D.

IRRIGATION.

ARID Regions.
Their Currents Turned Awry. H. A. Crafts. Describes the modes of storing water for irrigation, and gives an illustrated account of the diversion of water from the head of the Big Laramie River to the Cache la Poudre River. 1600 w. Harper's Wk—June 12, 1897. No. 13338.

NORTH-WEST Territories.
Irrigation in the Northwest Territories. William Pearce. A general talk on the benefits of irrigation and the advantage to be derived from its use in all localities. 2000 w. Can Eng—June, 1897. No. 13280.

PRACTICAL Points.
Some Practical Points in Irrigation Engineering. R. C. Gemmell. Hints to the young engineer regarding irrigation surveys and construction 4500 w. Technic—1897. No. 13762 D.

MISCELLANY.

BENDING Moment.
See Architecture and Building. Miscellany.

BLACKWALL Tunnel.
The Blackwall Tunnel Beneath the Thames. Illustrated detailed description with information regarding cost, machinery, &c. 7000 w. Sci Am Sup—July 3, 1897. No. 13770.

The Opening of the Blackwall Tunnel. Reviews the history of the project. 8000 w. Trans—May 28, 1897. No. 13298 A.

CEMENT.
The New Normal Cement of the Hungarian Engineering Society. (Die neuen Cement—Normalien des Ungarischen Ingenieur--und Architekten-Vereines.) An account of the standard cement adopted by the society, giving the mesh of screens, the proportion of mixture, and the tests which must be sustained. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 28, 1897. No. 13518 B.

See "Slag," under Mining and Metallurgy, Iron and Steel.

CONFERENCE.
The Institution of Civil Engineers. Report of the London conference, with abstracts of papers read, and discussions. 31500 w. Eng, Lond—May 28, 1897. No. 13318 A.

ENGINEER.
The Engineer and the National Society. Benjamin Morgan Harrod. Extracts from the address at the annual convention at Quebec, with editorial. Calls attention to some of the relations of a national society to the profession. 3500 w. R R Gaz—July 2, 1897. No. 13815.

HYDRODYNAMICS.
The Gradual Variations in the Flow of Water in Channels of Large Section. (Écoulement graduellment Varié des liquides dans les lits à grande section.) An elaborate mathematical treatment of the subject by M. Boussinesq, giving the derivation of the fundamental equations. 3000 w. Comptes Rendus—May 31, 1897. No. 13556 D.

HYDROGRAPHIC Surveys.
Some Methods of Making Hydrographic Surveys. Charles T. Dixon. Describes methods used on the Detroit and St. Mary's rivers for determining the contour of the bottom of a stream or channel, enabling the amounts of material above any required depth to be computed. 4000 w. Technic—1897. No. 13756 D.

MAGNETIC Surveys.
The Engineering Value of Magnetic Surveys. William S. Aldrich. Abstract of paper presented at the annual meeting. Matters of interest and importance relating to the bearing of magnetic observations on engineering development. 1000 w. Jour Assn of Engng Soc—May, 1897. No. 13661 C.

PLANIMETER.
See Mechanical Engineering.

PUZZOLANA.
Puzzolana and its Practical Use. Josef Zervas. Information regarding one of the oldest materials used for making mortar, especially hydraulic mortars. 4200 w. Sch of Mines Quar—April, 1897. No. 13454 D.

ROADS.
Good Roads. Daniel B. Luten. A criticism of American methods of road improvement, with reference to the system in France, and discussion of cost. 1800 w. Technic—1897. No. 13764 D.

SCHOOLS.
See same title under Mechanical Engineering.

SURVEYING.
The Comparison of Measurements by Least Squares. (Ueber Ausgleichung von Linienverbindungen bei Kleinmessungen.) Giving working examples of the determination of the probable error in a system of measurements by the method of least squares, without the necessity of geometrical construction. 7500 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13524 D.

TUNNEL.
Tunnel Roof-Shield Used in the Boston Subway. Illustrated description of the form of shield used. 1500 w. Eng News—June 24, 1897. No. 13682.

TRANSCONTINENTAL Arc.
The Transcontinental Arc from Cape May to San Francisco. E. D. Preston. Considers the determination, accuracy and usefulness. 5800 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13666 D.

WINDMILLS.
See same title under Mechanical Engineering, Power and Transmission.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BRITISH Guiana.

Tariff of British Guiana. A copy of the tariff ordinance for the year 1897-98; also, a statement taken from the *Argosy*, showing the increase and decrease on different articles as compared with last year. 4500 w. Cons Repts—June, 1897. No. 13652 D.

BRITISH Trade.

Do Foreign Annexations Injure British Trade? Henry Birchenough. Examines the British trade with foreign colonies, showing that Gt. Britain succeeds in carrying on a valuable export trade with the colonies of foreign powers, and stating the advantages of the country over her rivals. 4500 w. Nineteenth Cent—June, 1897. No. 13394 D.

BUSINESS Conditions.

The State of Trade. An analysis of business conditions based on interviews with manufacturers and wholesale merchants at more than fifty cities, showing moderate improvement at western centers, with less evidence of gain in the east. 2500 w. Bradstreet's—June 26, 1897. No. 13689.

CHINA.

Commercial Trend of China. Thomas R. Jernigan. Discusses some of the efforts of European nations to enlarge their trade relations, and gives statistics helpful to the business man in forming an opinion as to the direction in which the volume of China's trade is moving. 2200 w. N Am Rev—July, 1897. No. 13755 D.

FAILURES.

Business Failures Classified. Enumeration of the total number of concerns engaged in business in thirty-seven lines of trade, and the number of failures in 173 lines of business in 1894, 1895, and 1896. 5000 w. Bradstreet's—June 5, 1897. No. 13281.

Business Failures for Six Months. Report and tables of comparison. The past six months not as favorable as was anticipated. 1400 w. Bradstreet's—July 3, 1897. No. 13821.

FOREIGN Commerce.

New York's Decreasing Share in Our Foreign Commerce. Showing that all branches of export business of New York are threatened. 1200 w. Bradstreet's—June 19, 1897. No. 13601.

GERMANY.

Trade and Training in Germany. Extracts from and comments upon a recent discussion of this subject by Sir Philip Magnus, in the London *National Review*. 5000 w. Gunton's Mag—July, 1897. No. 13801 C.

JAPAN.

The Encouragement of Industry in Japan. Discusses three bills submitted to the Diet this session which have special interest for foreigners. 1600 w. Bd of Trd Jour—June, 1897. No. 13695 A.

Yokohama Chamber of Commerce. A few remarks on some of the points mentioned in the annual report of this organization. 1600 w. Engng—June 4, 1897. No. 13409 A.

MANUFACTURED Exports.

British *versus* American Manfactured Productions. Editorial comment on the increase of American productions, the advantages possessed by Americans, and the effect upon British mechanical industries. 1800 w. Ir & Coal Trds Rev—June 11, 1897. No. 13631 A.

PRICES.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle, and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from Jan. 1, 1893, to June 1, 1897, Covering the Period of Recent Extreme Depression. Table. Bradstreet's—June 12, 1897. No. 13395.

PROTECTION.

Philosophy of Protection. Considers the two cardinal elements of tariff legislation to require an intelligible understanding of the purpose of protection and a knowledge of the incidence of tariff taxation, and discusses these points. 3000 w. Gunton's Mag—July, 1897. No. 13798 C.

RUBBER Goods.

Meeting of Mechanical-Goods Makers. A conference to bring about general good feeling and discuss the conditions of this industry, with the view of regulating prices. Also editorial. 2000 w. Ind Rub Wld—June 10, 1897. No. 13621 D.

SOUTH AMERICA.

How to Get South American Trade. John A. Johnson. Presents mainly the necessity of better means of communication. Taken from a pamphlet published by the writer. 1800 w. Ir Trd Rev—June 24, 1897. No. 13679.

TARIFF.

Customs Tariff of Russia. Consular report of duties imposed by Russia upon some of the principal articles exported by the United States. 2500 w. Cons Repts—June, 1897. No. 13-648 D.

New Customs Tariff of Canada. A copy of the resolutions proposed in the Committee of Ways and Means of the Canadian House of Commons relative to duties of customs, excise, &c. 3700 w. Bd of Trd Jour—June, 1897. No. 13696 A.

Tariff Changes and Customs Regulations. Netherlands—Curacoa, France, Tunis, Portugal, Italy, Roumania, United States of Colombia, British India, St. Christopher—Nevis, Montserrat, Queensland. 3300 w. Bd of Trd Jour—June, 1897. No. 13697 A.

The Tariff Revolution in Canada. Hartley Withers. Discusses the recent changes in the Canadian tariff, chiefly from the commercial standpoint. 2500 w. Bankers' Mag, Lond—June, 1897. No. 13344 A.

TRADE Relations.

The South and the West. John A. Smith. Extracts from an address at Kansas City giving information and suggestions of practical value in the development of closer trade relations. 3000 w. Tradesman—June 15, 1897. No. 13-608.

CURRENCY AND FINANCE.

COINAGE Bill.
Text of the Japanese Coinage Bill. A copy of the bill as translated and published by the *Japan Herald*. 1000 w. Cons Repts—June, 1897. No. 13651 D.

GOLD Standard.
The Gold Standard in Japan. A copy of the formal statement made by Count Matsukata, the Premier, before the Japanese Diet, as to the plan suggested by the cabinet for placing the circulation on a gold basis. 4500 w. Cons Repts—June, 1897. No. 13650 D.

The Greenback and the Gold Standard. Marriott Brosius. Concludes that to deprive the government of the means of maintaining gold payments, and preserving the parity of all our money, and to relegate these functions to private banking institutions would be full of peril. 3300 w. N Am Rev—July, 1897. No. 13754 D.

JAPAN.
Japan's Monetary Somersault. W. R. Lawson. A lengthy discussion of monetary affairs in Japan, especially the gold standard scheme which has recently become a law. 5300 w. Bankers' Mag, Lond—June, 1897. No. 13343 A.

SAVINGS Bank.
The Savings Bank as a Public School of Primary Economic Instruction. William L. Trenholm. Address delivered at the annual meeting of the Savings Banks' Assn. of the State of New York. The necessity of educating the masses in elementary economics. 3000 w. Bank's Mag, N Y—June, 1897. No. 13452 D.

SILVER.
Silver and Prices: The Economic Drain from Debtor Nations. Moreton Frewen. An interesting discussion of the problem of the future exchange value of money—or "how the white man with the yellow money is to meet the competition of the yellow man with the white money." Discussion follows. 7500 w. Jour Soc of Arts—May 28, 1897. No. 13352 A.

LABOR.

AMERICAN Shipping.
See Marine Engineering.

IMMIGRATION.
The Immigration Question. J. H. Senner. Recommends the placing of the distribution of settlers and laborers under the responsible management of a National Land and Labor Clearing House; to exclude all undesirable immigrants and at the same time see that the most desirable are properly distributed over the country. 5400 w. An Am Acad—July, 1897. No. 13825 G.

LABOR.
Labor Problems of To-day. Part first consists of introductory remarks aiming to present existing conditions. 2500 w. Ir & Coal Trds Rev—June 4, 1897. Serial. 1st part. No. 13403 A.

STRIKES.
Strikes in Japan. Fusataro Takano. A rather pessimistic view of the present labor conditions in Japan, with editorial comment. 2200 w. Gunton's Mag—July, 1897. No. 13800 C.

WORKMEN'S Bill.
The Economic Effects of the Workmen's Compensation Bill. Emerson Bainbridge. Aims to show the effect of the bill upon those who are supposed to be benefitted, on those who are asked to pay the costs, and upon the general trade. 1800 w. Ir & Coal Trds Rev—May 28, 1897. No. 13354 A.

MISCELLANY.

CHEAPNESS.
Is Cheapness an Evil? George Allen White. The subject is discussed from one standpoint by the writer, and replied to editorially from another point of view. 2200 w. Gunton's Mag—July, 1897. No. 13802 C.

PATENT System.
The Patent System as a Factor in National Development. William C. Dodge. Showing how invention and production have increased under the United States patent laws. 4200 w. Eng Mag—July, 1897. No. 13807 B.

PRODUCTION.
Governments and Co-operative Production. Editorial discussion of the co-operative principle and its difficulties, based upon the report of D. F. Schloss to the Labor Department of the Board of Trade. 2500 w. Engng—June 18, 1897. No. 13710 A.

WEALTH Distribution.
Dangers of a Wrong Point of View. Discusses a book published by Dr. Charles B. Spohr on "The Present Distribution of Wealth in the United States," criticising it as a violent misrepresentation arising from a wrong point of view. 3500 w. Gunton's Mag—July, 1897. No. 13799 C.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

CONSERVATION of Energy.
The Principle of the Conservation of Energy in Electrochemistry. (Das Prinzip der Erhaltung der Energie in der Elektrochemie.) A scholarly investigation of an important phase of the great problem of the conservation of the physical forces. 4000 w. Deutsche Zeitschrf Elektrotechnik—April, 1897. No. 13586 B.

ELECTROLYSIS.
Notes on the Electrolysis of the Alkaline Bromides and Fluorides. (Beiträge Zur Elektrolyse der Alkali-Bromide und Fluoride.) Showing the arrangement of apparatus and giving the details of the reactions. 4000 w. Zeitschr f Elektrochemie—May 5, 1897. No. 13590 B.

The Electrolysis of Mixtures. (Zur Elektrolyse von Gemischen.) An examination of the chemical theory and practice of the electrolysis of mixtures according to Hittorf's theory. 7500 w. Zeitschr f Elektrochemie—May 20, 1897. No. 13592 B.

The Electrolytic Reduction of Nitro-Benzole. (Elektrolytische Reduktionen des Nitro Benzols.) Giving details of solutions used and proper currents to effect the desired reduction. 2500 w. Zeitschr f Elektrochemie—May 5, 1897. No. 13589 B.

The Influence of Time upon the Cathode Action in Electrolysis of Copper Solutions. (Ueber den Einfluss der Zeit auf den Kathoden Vorgang bei Elektrolyse der Kupfersulfatlösung.) Giving graphical records of a number of experimental investigations. 4000 w. Zeitschr f Elektrochemie—June 5, 1897. No. 13593 B.

SODIUM Peroxid.

Making Sodium Peroxid at Niagara. Orrin E. Dunlap. Describes the electrical equipment of the Niagara Electro-Chemical Co. Ill. 500 w. Elec Eng—June 23, 1897. No. 13714.

LIGHTING.

ACCUMULATORS.

Accumulators—Their Application to Central Station Lighting and Power W. A. Johnson. Read before the Can. Elec. Assn. Presents the advantages and adaptability of accumulators, and the cost. 1800 w. Can Elec News—June, 1897. No. 13484.

ARC Lamp.

Progress of the Enclosed Arc Lamp. Louis B. Marks. The development, progress and commercial success. 900 w. Elec Wld—June 5, 1897. No. 13326.

The Enclosed Arc Lamp. E. L. Nichols. Read before the Cornell Electrical Soc. Consides some of the peculiarities of this lamp, its advantages, tests, &c. 1800 w. Sib Jour of Engng—June, 1897. No. 13424 C.

ARC Lighting.

Recent Progress in Arc Lighting. Elihu Thomson. Abstract of a paper read before the Niagara Falls convention of the National Electric Light Assn. The writer thinks the immediate future of the series arc lighting system appears to be in the development of large dynamos. Considers pulsating currents, constant potential arc work, inclosed arcs, results of tests, &c. 5500 w. Elec Wld—June 12, 1897. No. 13447.

BRIGHTON, England.

The Electric Lighting of Brighton, England. Fred Bathurst. A brief illustrated description of the electric lighting features of this popular seaside resort. 5700 w. Am Elect'n—June, 1897. No. 13384 C.

CONVENTION.

National Electric Light Association. Report of the proceedings of the convention held at Niagara Falls, June 8, 9, and 10, 1897. 6000 w. Elec Wld—June 12, 1897. No. 13448.

DAY Load.

A Profitable Day Load for a Large Central Station. C. H. Wilmerding. Examines the subject from various points of view, and suggests a method for establishing rates. 2000 w. Elec Wld—June 5, 1897. No. 13327.

Day Loads for Central Stations, and How to Increase Them. J. A. Kammerer. Read before Can. Elec. Assn. States the points that commend themselves from a lighting standpoint. 1800 w. Can Elec News—June, 1897. No. 13483.

The Daylight-Work of Central Stations. Abstract of a paper read before the convention of the National Electric Light Assn., at Niagara Falls, by Thomas Commerford. Traces the development of the industry, and the improvement in the last ten years. 1400 w. Elec Wld—June 12, 1897. No. 13444.

ELECTRICAL Equipment.

Electrical Equipment of a Model Commercial Building. Illustrated detailed description of the electrical equipment of the Silversmiths' building in Chicago. 2200 w. W Elec—June 12, 1897. No. 13416.

HOTEL Cecil.

The Electric Plant at the Hotel Cecil. Illustrated description of the electric lighting arrangements, with particulars of the costs of production for various months. 2800 w. Elec Eng, Lond—June 4, 1897. No. 13396 A.

INCANDESCENT Lamps.

High and Low Voltage Incandescent Lamp. John W. Howell. Presents the advantages of high voltage lamps, and the difficulties to be overcome in the manufacture of the lamps. 1500 w. Elec Wld—June 5, 1897. No. 13323.

Report of Committee on Standard Candlepower of Incandescent Lamps. Presented at the National Electric Light Assn. convention at Niagara Falls. Work of the committee with recommendations. 2200 w. Elec Eng—June 16, 1897. No. 13464.

LAMPS.

220-Volt Lamps. Alfred H. Gibbings. Considers this lamp and the reasons for and benefits accruing from its adoption. 2000 w. Am Elect'n—June, 1897. No. 13392 C.

LIGHTING.

Artistic Electric Lighting. A criticism of the inartistic work often seen, and a description of a place recently opened in Glasgow, known as "Miss Cranston's New Lunch and Tea Rooms," which is highly praised. Ill. 2000 w. Elec Eng, Lond—June 18, 1897. No. 13722 A.

Municipal Ownership. M. J. Francisco. Criticisms unfavorable to municipal ownership, and claiming that reports made are not reliable. 3300 w. Elec Wld—June 5, 1897, No. 13325.

See same title under Railway Affairs, Maintenance of Equipment.

Why Some Lighting Plants Do Not Pay. F. C. Armstrong. Discusses principally failure by reason of mistakes in management and business methods. 2800 w. Can Elec News—June, 1897. No. 13477.

Municipal Lighting. W. Worth Bean. Abstract of a paper read before the National Electric Light Assn. at Niagara Falls. Opposed to municipal lighting. 2200 w. Elec Eng—June 16, 1897. No. 13459.

ROUEN, France.

Central Station of Rouen, France. Jules Laffargue. An illustrated detailed description of one of the most interesting stations in France, both in consequence of special features, and good results. 3000 w. Am Elect'n—June, 1897. No. 13385 C.

SMALL Towns.

Electrical Plants for Small Towns. Alexander Dow. Read before the Engineering Soc. of Univ. of Mich. Calls attention to points to be

considered in relation of design, location, &c., and to details often overlooked. 8000 w. Technic—1897. No. 13759 D.

SPRINGFIELD, Mass.

The Indian Orchard Water Power Transmission Plant of the United Electric Light Co., Springfield, Mass. An illustrated account of the water power station which has brought about the shutting down of the company's steam plant and practically transferred its generating plant beyond the city limits. 2500 w. Elec Eng—June 9, 1897. No. 13336.

STATION.

A Modern American Central Station. F. W. Roller. Illustrated description of the plant of the Suburban Electric Co., Elizabeth, N. J. 3000 w. Am Elect'n—June, 1897. No. 13383 C.

The Polyphase Station at the Budapester Allgemeine Electricitäts Gesellschaft. Francis Jehl. Illustrated description with information regarding efficiency. 2500 w. Elect'n—June 18, 1897. No. 13721 A.

STEAM Power.

The Steam End of an Electric Plant. A. M. Wickens. An inquiry into the working, the efficiency and cost of operating an electrical plant by steam. 2500 w. Can Elec News—June, 1897. No. 13482.

SWITCHBOARDS.

Central Station Switchboard Construction. Albert B. Herrick. Discusses designs and devices used in switchboard operation, and the working of the various systems. Ill. 3000 w. Elec Wld—June 26, 1897. No. 13749.

TACHOMETER.

A Simple Electrical Recording Tachometer. L. E. Jones. Describes and illustrates a tachometer constructed and used by the writer at the electric light plant of the West Chicago parks, that proved itself useful in quickly and accurately indicating the number of revolutions, as well as any slipping occurring in the many clutches, the jack drive, the rope drive and pulleys. 1200 w. Elec Rev—June 23, 1897. No. 13646.

WATER Power.

Water Driven Plants. John Murphy. Read before the Can. Elec. Assn. Deals in a general manner with the operation of water driven lighting and power plants. 1100 w. Can Elec News—June, 1897. No. 13481.

WIRING.

Report of the National Electric Light Assn. Committee on Safe Wiring. Presented at the Niagara Falls meeting. Reports the obstacles overcome and work done by the committee. 2400 w. Elec Eng—June 16, 1897. No. 13462.

Some Things About Wiring and Wiremen. S. H. Sharpsteen. Part first calls attention to the fact that every job has some new condition to meet, and briefly discusses where to enter with the service wires. 1500 w. Elec Eng—June 30, 1897. Serial. 1st part. No. 13814.

POWER.

ACCUMULATORS.

Note on the Theory of Lead Surfaces. (Ein Beitrag zur Theorie des Bleisammlers.) Discussing the chemical and electrical action of leaden plates in accumulators. 5000 w. Zeitschr f Elektrochemie—June 5, 1897. No. 13594 B.

The Blot Accumulator. (Der Blot Akkumulator.) This new storage battery cell is composed of narrow strips of corrugated lead, wound on leaden bobbins, these latter being built up into plates. Tests by d'Arsonval, de Nerville, and Preece, show most excellent results. 1500 w. Zeitschr d Ver deutscher Ing—May 22, 1897. No. 13500 B.

The Dependence of Capacity of Accumulators upon the Strength of Charging Current. (Ueber die Abhängigkeit der Kapacität von der Entladestromstärke bei Bleiakkumulatoren.) Giving the results of numerous tests of the various makes of accumulators, by Prof. Penkert. 1500 w. Elektrotechnische Zeitschr—May 20, 1897. No. 13572 B.

The Use of Accumulators in Central Station Practice. Clayton H. Sharp. Read before the Electrical Soc. of Cornell Univ. Discusses the advantages accruing from the use of an auxiliary accumulator plant in caring for irregular loads. 3000 w. Sib Jour of Engng—June, 1897. No. 13428 C.

ALTERNATING Current.

The Use of Alternating Current. Part first considers its application to street railway service, phase relation, impedance, capacity, self-induction, wave forms and torque. Ill. 3000 w. St. Ry Rev—June 15, 1897. Serial. 1st part. No. 13491 C.

CIRCUITS.

Economy in Circuits. D. H. Keeley. Diagrams and explanation with the view of showing that without exceeding the weight of copper, or the drop of E. M. F. in current transmission, found in a single parallel system, it is possible to provide for distribution with an equalized pressure at all points. 1200 w. Can Elec News—June, 1897. No. 13479.

COMMUTATORS.

See same title under Mechanical Engineering, Shop and Foundry.

CONTINUOUS Current.

Interaction between Armature and Field in the Continuous Current Dynamo. H. H. Norris. Describes the commutator and its use, with its action. 1500 w. Sib Jour of Engng—June, 1897. No. 13426 A.

CONVERTER.

The Rotary Converter. C. P. Steinmetz. Discussion of the subject, applying principally to polyphase rotary converters. 3000 w. Sib Jour of Engng—June, 1897. No. 13423 C.

DROP.

Drop in Alternating-Current Lines. Ralph D. Mershon. Treats this subject in such a manner that the results may be turned to practical advantage. 3500 w. Am Elect'n—June, 1897. No. 13391 C.

DYNAMO Calculation.

The Induction Factor, a New Basis of Dynamo Calculation and Classification. Charles A. Carus-Wilson. Read before the N. E. L. A. Showing the use of the induction factor in dynamo calculations, giving examples. 2500 w. Elec Eng—June 16, 1897. No. 13460.

DYNAMOS.

Interpretation of Dynamo Characteristics. H.

J. Hotchkiss. Read before the Electrical Soc. of Cornell Univ. The aim of the paper is to call attention to a few of the fundamental ideas that may serve as a general basis for the interpretation of characteristic curves. 1200 w. Sib Jour of Engng—June, 1897. No. 13429 C.

See Mechanical Engineering, Engines and Motors.

ELECTRIC Power.

See same title in Marine Engineering.

ELECTRICAL Transmission.

See same title under Mining and Metallurgy, Coal and Coke.

EXTENSIONS.

Profitable Extensions of Electricity Supply Stations. Abstract of paper read before the convention of the National Electric Light Assn., by Arthur Wright. An endeavor to show the most profitable fields for extension and profit-earning. 1800 w. Elec Wld—June 12, 1897. No. 13445.

LEAKAGE.

The Best Means of Effectually Preventing the Leakage of Current to "Earth" in Electrical Installations from Generating Heat and Setting Buildings on Fire. Sydney F. Walker. Considers (1) what do we mean by earth? (2) how does leakage of current to earth occur in electrical installations? (3) how does this leakage current generate heat? (4) what are the best means for its prevention? 3700 w. Elec Eng, Lond—June 11, 1897. Serial. 1st part. No. 13632 A.

LINE Effects.

The Line Effects in Alternating-Current Transmission. H. E. Raymond. A recital of some "line" incidents resulting from some of the most prominent of the so-called "effects." 1800 w. Am Elect'n—June, 1897. No. 13-390 C.

MACHINERY.

See same title under Mining and Metallurgy, Coal and Coke.

OGDEN, Utah.

The Power Plant of the Pioneer Electric Power Company of Ogden, Utah. Detailed description of an interesting piece of engineering work, as given in a paper by Henry Goldmark, presented to the Quebec convention of the American Soc. of Civ. Engs. Ill. 7500 w. Eng Rec—June 19, 1897. Serial. 1st part. No. 13497.

POTENTIOMETER.

The Direct Reading Potentiometer. Description of instrument made by Messrs. Elliott Bros., with illustrations. The method of making tests and measurements with it is also described. 3000 w. Elec Rev, Lond—June 11, 1897. No. 13633 A.

POWER.

Multiple-Expansion Engines and the Cost Account. R. H. Thurston. The purpose of the article is to state briefly the facts and principles mainly influential in determining the best engine to adopt for a light or power station. 5000 w. Am Elect'n—June. No. 13388 C.

POWER Distribution.

Electric Power Distribution at Sandycroft. Illustrates and describes some parts of the system in use by the Sandycroft Foundry and Engine Works Co. 1000 w. Elec Rev, Lond—June 18, 1897. No. 13739 A.

POWER Plant.

The Electric Power Plant of the New Reichstags Building in Berlin. (Elektromoterische Antriebe im neuen Reichstagshause zu Berlin.) Describing the elaborate electric driving system for ventilators, and pumps, with illustrations. 2500 w. Zeitschr d ver deutscher Ing—May 29, 1897. No. 13504 B.

POWER Transmission.

The Economies of Power Transmission. Louis Bell. Discusses the items of cost and the probable sources of revenue. 3000 w. Am Elect'n—June, 1897. No. 13387 C.

STATION.

Electric Station Design. I. J. Macomber. Read before the Electrical Soc. of Cornell Univ. Considers only the design of stations that use steam as a motive power. Ill. 3000 w. Sib Jour of Engng—June, 1897. No. 13427 C.

STEAM TURBINE.

The Application of the Steam-Turbine to the Working of Dynamos and Alternators. Charles Algernon Parsons. Brief description of the compound steam-turbine and statement of its advantages for driving dynamos and alternators, with short discussion. Presented at Civil Engineers Conference. 1200 w. Elec Eng, Lond—May 28, 1897. No. 13292 A.

TIDE Power.

The Application of Electricity to the Utilization of Natural Water Power. (Die Auwendung der Elektrischen Kraflübertragung auf die Nutzbarmachung der Natürlichen Wasserkräfte.) A discussion by Dr. Voller, of the possibility of utilizing tide power with especial reference to the proposed application at Hamburg. 3000 w. Die Elektrizitat—May 8, 1897. No. 13566 B.

TRANSFORMATION.

Frequency Transformation. F. Jarvis Patten. Considers this subject and describes an apparatus from which almost any desired frequency can be derived from a given frequency. Ill. 2700 w. Elec Wld—June 12, 1897. No. 13446.

TRANSMISSION.

See Mechanical Engineering, Power and Transmission.

The Long Distance Electrical Transmission Between Folsom and Sacramento, Cal. Illustrated detailed description. 4500 w. Eng, Lond—June 11, 1897. No. 13618 A.

The Niagara Power Transmission Line. J. G. White. History and description. 3500 w. Elec Eng—June 16, 1897. No. 13463.

The Transmission of Power. A discussion of the subject of the modes of transmitting power concluding with three facts that point strongly to the ultimate triumph of electrical transmission for a large portion of industrial conditions. 3000 w. Eng, Lond—June 4, 1897. No. 13410 A.

TELEGRAPHY AND TELEPHONY.

AUTOMATIC Telegraphy.

Automatic Telegraphy. Patrick B. Delany. Part first discusses the best speed obtainable with the Morse and with the Wheatstone system. 2200 w. Elec Eng—June 23, 1897. No. 13-716.

BERLINER Patent.

The Berliner Patent and the Government Suit. R. S. Taylor. Address of the chief counsel for the government in the Berliner case, at the Convention of Independent Telephone Assn. 4000 w. Elec Wld—June 26, 1897. No. 13752.

CABLES.

The Burke System of Cable Telegraphy. Mr. Charles G. Burke's invention is an adaptation of Morse work to long submarine cables and other telegraph lines where large static capacity is an obstacle to the use of ordinary Morse signals. Ill. 1200 w. Elec Eng—June 23, 1897. No. 13717.

The Electrostatic Capacity of a Two-Wire Cable. George W. Patterson. Briefly derives the expression for the capacity of a single wire cable and from that passes to the capacity of a two-wire cable. 700 w. Technic—1897. No. 13766 D.

The Working of the Telegraph Cable from Germany to Norway. Albert Petersen. Abstract of an article in the *Elektrotechnische Zeitschrift*, translated from the *Telegrafbladet*. A statement of difficulties and method devised to remedy them. 800 w. Elect'n—June 11, 1897. No. 13626 A.

CONNECTIONS.

Trunk Line Connections for Independent Telephone Exchanges. Some remarks concerning the proper methods for the establishment and maintenance of trunk lines between various exchanges. 1700 w. Elec Wld—June 19, 1897. No. 13628.

DUPLEX Telegraphy.

A New Duplex Telegraph System. (Neues Zweifach telegraphensystem.) A simple system which has worked well without condensers over a line 230 miles long, for over three years. 2000 w. Elektrotechnische Zeitschr—May 13, 1897. No. 13571 B.

Duplex Telegraphy in Switzerland with the Hughes Apparatus. (Duplex telegraphie mit dem Hughes-Apparat in der Schweiz.) Describing the performance of the first Hughes duplex line in Switzerland, between Bern and Basle. 2000 w. Elektrotechnische Zeitschr—May 20, 1897. No. 13573 B.

INDEPENDENT Telephones.

Independent Telephone Companies.—Their Legal Status and Their Prospects for the Future. A. B. Guigon. Discusses the effect of the recent decision in the Berliner patent, and the union now forming, with matters to be considered at the coming meeting in Detroit. 2000 w. Elec Wld—June 19, 1897. No. 13629.

Meeting of Independent Anti-Bell Telephone Interests at Detroit, June 22 and 23, 1897. Account of meeting, presidential address, &c. 16500 w. Elec Eng—June 23, 1897. No. 13-718.

The Independent Telephone Movement. James M. Thomas. Presidential address discussing the attitude of this organization to the Bell Telephone Co. 2400 w. Elec Wld—June 26, 1897. No. 13751.

MILITARY Telegraph Lines.

Pole Climber and Pole Sinking Tool on the U. S. Military Telegraph Lines. W. A. Glassford. Description of tool and its working. 1200 w. Elec Eng—June 23, 1897. No. 13715.

RESONANCE.

Electrical Resonance. Remarks on this subject, with reference to a paper read before the Chicago Electrical Assn., by Kempster B. Miller. Ill. 1800 w. Elec Rev, Lond—June 4, 1897. No. 13397 A.

TELEPHONES.

Telephone Lines. Considers the troubles arising from earth's magnetic disturbances, leakage currents, and inductive effects of neighboring conductors. 1300 w. Am Elect'n—June, 1897. No. 13393 C.

The Stromberg-Carlson Telephone Apparatus. Illustrated detailed description. 1500 w. Elec Rev—June 30, 1897. No. 13753.

TELEGRAPHY Without Wires.

Ethereal Telegraphy. Editorial on the investigations in this field. 1800 w. Eng, Lond—May 28, 1897. No. 13319 A.

Signalling Through Space Without Wires. W. H. Preece. Delivered before the Royal Institution, June 4, 1897. Explains the system of telegraphy invented by Signor Guglielmo Marconi, and describes his own experiments. Also editorial. Ill. 4800 w. Elec Rev, Lond—June 11, 1897. No. 13634 A.

MISCELLANY.

COST.

The Cost of Electric Energy in 1896. A. P. Haslam. Graphical representation, with explanation, showing that progress has been the rule, and the prosperous condition of the electricity supply business. 1700 w. Elec, Lond—June 18, 1897. Serial. 1st part. No. 13725 A.

CURRENT Price.

The Establishment of a Base Price for Current. J. B. Cahoon. Abstract of paper read before the N. E. L. A. Outlines a plan for determining the base price which should be charged per kilowatt hour. 1400 w. Elec Eng—June 16, 1897. No. 13461.

ELECTRICAL Machinery.

Repairs of Electrical Machinery. False Alarms. A. R. Harris. Shows that when a machine behaves abnormally, there is often simply some part slightly out of adjustment, or an accumulation of dirt at some point where it can interfere with the proper action. Ill. 2000 w. Am Mach—June 10, 1897. No. 13371.

ELECTRICAL Waves.

Electrical Waves and Oscillation. Ernest Merritt. Read before the Electrical Soc. of Cornell Univ. Explains experiments illustrating electrical oscillations and waves, and gives such information as has thus far been gained in regard to them. 5200 w. Sib Jour of Engng—June, 1897. No. 13430 C.

FURNACE.

A New Electric Furnace, (Nouveau Four Électrique.) The Lelièvre furnace is of the cupola type with carbons at bottom, and the escaping gases are used to heat the incoming material. 1000 w. La Revue Technqiue—May 10, 1897. No. 13541 D.

FUTURE Possibilities.

The Future Possibilities of Electricity. F. A. C. Perrine. An attempt to show how it will be

possible for this new means of power transmission and utilization to change certain industries, and to prove that these changes will materially influence localities. 3800 w. Elec Engng—July 1, 1897. No. 13772.

GALVANOMETER.

On the Measurement of Alternate Currents by Means of an Obliquely Situated Galvanometer Needle, with a Method of determining the Angle of Lag. Lord Rayleigh. From the Phil. Mag. Describes a form of galvanometer suitable for the measurement of alternate currents, and how the instrument can be used to measure the power factor of a circuit. 2200 w. Elect'n—June 4, 1897. No. 13420 A.

MAGNETISM.

See Mining and Metallurgy, Iron and Steel.

NIAGARA FALLS.

Electricity at Niagara Falls. A brief and concise review of the present situation with respect to electrical development, with particular reference to the newest applications and to details of operation. Ill. 5700 w. Am Elect'n—June, 1897. No. 13389 C.

Niagara Falls as an Electrical Center. Orrin E. Dunlap. Describes the changes wrought and calls attention to the installations of special interest to electricians. Ill. 2400 w. W Elec—June 12, 1897. No. 13415.

The Electrical Features of Niagara. Illustrated description of the Niagara Falls Power Co., the Power Transmission Line, the Railway, Hydraulic Power & Manufacturing Co., the Carborundum Co., and other industries. 7000 w. Elec Wld—June 5, 1897. No. 13328.

PHYSIOLOGICAL Electricity.

Physico-Chemical Principles and the Application of Cataphoris in Medicine. (Physikalisch Chemische Grundlage und Anwendung der Kataphorese in der Medizin.) A fundamental discussion of the application of the electrical transfer of particles to medicine. 6000 w. Elektrochemische Zeitschr—June, 1897. No. 13588 B.

ROENTGEN Rays.

A Speculation Regarding the Cause of Roentgen Rays. Elihu Thomson. Speculations presented in the hope that they may aid in investigation. 2000 w. Elec Wld—June 26, 1897. No. 13748.

SAFES.

Burglarizing Safes by Electricity. L. L. Summers. An account of experiments made, with charts giving some of the results, showing that any arguments based upon the assumption that a metal wall cannot be penetrated by currents obtained from electric light plant, or storage battery, are fallacious. 1000 w. Elec Engng—June 15, 1897. No. 13303.

SAFETY Fuse.

A New System of Electric Protection. (Einneues System Elektrischer Sicherungen.) The improved Hundhausen safety cut-out which throws in a suitable resistance when melted is now used by Siemens & Halske in the latest installations. Two articles. 5000 w. Die Elektrizität—May 22, June 5, 1897. No. 13568 D.

VOLTAMETER.

The Copper Voltameter. (Ueber das Kupfer-Voltameter.) Describing the practical use of the voltameter for electrical measurements by the decomposition of copper solutions. Two articles. 6000 w. Zeitschr f Elektrochemie—May 5, 20, 1897. No. 13591 E.

MARINE ENGINEERING.

AMERICAN Shipping.

What American Shipping Means to American Labor. From the *American Economist*. Showing how the United States can benefit by a proper maritime policy. 1800 w. Sea—June 24, 1897. No. 13675.

BATTLESHIPS.

Naval Review at Spithead. Illustrated account, with description of the various battleships belonging to Great Britain. Also editorial. 2000 w. Eng, Lond—June 18, 1897. No. 13732 A.

BULKHEADS.

Marine Registry Rules for Watertight Bulkheads in Mail and Passenger Steamers. (Vorschriften der Seeberufsgenossenschaft über Wasserdichte Schotte für Post- und Passagierdampfer.). A paper by Herr Middendorf, discussing the method of determining the number and location of watertight bulkheads, with many illustrations and working diagrams. The official method of the German Lloyds. Two articles. 1 plate. 12000 w. Zeitschr d Ver Deutscher Ing—May 29, June 5, 1897. No. 13503 E.

CARRYING-TRADE.

The Upbuilding of a Marine Carrying-Trade. John Codman. An argument for free ships, in answer to Lewis Nixon. 3200 w. Eng Mag—July, 1897. No. 13803 B.

CRUISERS.

American Built Cruisers for Japan. Illustrated description of a vessel to be built by the Union Iron Works of San Francisco. 900 w. Sci Am—July 3, 1897. No. 13768.

ELECTRIC Power.

Electricity on Shipboard. W. F. Durand. Read before the Electrical Soc. of Cornell Univ. Describes in detail the various applications. 4000 w. Sib Jour of Engng—June, 1897. No. 13425 C.

LAKE Shipping.

Wonders of Lake Shipping. Remarks on the enormous traffic of the Sault canal, the big vessels and despatch in loading. 1200 w. Bos Jour of Com—June 19, 1897. No. 13623.

NEW NAVY.

Three Samples from the New Navy. Illustrated description of the armored cruiser, New York, the battleship, Iowa, and the double-turreted monitor, Puritan. 1500 w. Am Mach—June 17, 1897. No. 13467.

OCEAN Travel.

The Place of Our Destination. John E.

Sweet. A comparison between a journey just completed, and one made thirty-five years ago is given in part first. 1600 w. Am Mach—June 17, 1897. No. 13470.

PADDLE Steamships.

Largest Paddle Steamship Afloat, British or American? Descriptions, with illustrations of the British steamship Empress Queen, being constructed for service in the Irish Sea, and the Priscilla of the Fall River Line, running from New York. 1200 w. Marine Engng—June, 1897. No. 13357 C.

PROPELLERS.

The Construction of Propellers. (Konstruktion von Schiffschrauben.) Giving a graphical solution by the projection of points from a hyperbola. 1200 w. Zeitschr d Ver Deutscher Ing—May 22, 1897. No. 13501 B.

QUARANTINE.

Quarantine and Port Sanitation. A. N. Bell. A forty years' review of the port of New York. Ill. 9800 w. San—June, 1897. No. 13-449 D.

REVENUE Cutter.

U. S. Revenue Cutter McCulloch for Service in Behring Sea. Illustrated description with trial trips and data. 1700 w. Marine Engng—June, 1897. No. 13356 D.

STEAMSHIPS.

The New Twin Screw Express Steamships of the North German Lloyd Company. Illustrated description of the Kaiser Wilhelm der Grosse and the Kaiser Friedrich. 1200 w. Sci Am—June 19, 1897. No. 13466.

The "William the Great" ("Kaiser Wilhelm der Grosse.") A description of the launch of this large vessel, with illustrations. The ship is 2,500 tons displacement, 648 feet long, 66 feet beam, 43 feet deep. 1500 w. Stahl und Eisen—June 1, 1897. No. 13562 D.

TIME.

International Unification of Time. (L'Unification Internationale des Heures.) A discussion of the subject of standard time for Europe, based upon the same system as that used in the United States. But three meridians would be necessary for all Europe. 3500 w. Le Génie Moderne—June 1, 1897. No. 13537 B.

TORPEDO Vessels.

The Battleship and the Torpedo Vessel. Editorial on the discussion at the Royal United Service Institution on the relative military virtues of the battleship and torpedo vessel, especially discussing Admiral Colomb's paper entitled "The Future of the Torpedo." 2200 w. Engng—June 11, 1897. No. 13610 A.

U. S. NAVY.

The American Fleet. J. D. Jerrold Kelley. Illustrative descriptive review of the ships of the United States navy. 7000 w. Harpers Wk—June 19, 1897. No. 13439.

VIBRATIONS.

Steamship Vibrations, with Records of Recent Observations. W. F. Durand. Part first discusses unbalanced reciprocating parts, unbalanced cranks, and unbalanced pressure on the guides. 3000 w. Marine Engng—June, 1897. No. 13358 C.

WATER TUBE Boiler.

Test of the Engel Marine Water Tube Boiler. Herbert G. Geer. Illustrates the general arrangement and gives account of test. 900 w. Power—July, 1897. No. 13783.

YACHTS.

A Modern Steam Yacht. Interesting description of the beautiful yacht built for Mr. Ogden Goelet, by the Clydebank Engineering and Shipbuilding Co. 3500 w. Engng—June 18, 1897. No. 13711 A.

Ancient Roman Yachts. From the N. Y. Sun. An account of the finding of the two ships of the Emperor Caligula, which have been buried for centuries at the bottom of Lake Nemi. 1000 w. Eng—June 5, 1897. No. 13368.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER Feeder.

A New Way to Feed Boilers. Illustrates an apparatus for supplying boilers with feed water with a much smaller expenditure of steam than is necessary with pumps. The Q. & C. Scott Boiler Feeder. 1200 w. Am Mach—June 17, 1897. No. 13468.

BOILER-SETTING.

Boiler-Setting and Furnace-Construction. Edgar Kidwell. Showing the requirements of boiler-setting and how to obtain them. Ill. 5200 w. Eng Mag—July, 1897. No. 13811 B.

HIGH-SPEED Engines.

Some Facts and Fancies Concerning High-Speed Engines. W. F. Cleveland. A letter to the editor objecting to the use of heavy reciprocating parts. 1000 w. Loc Engng—June 1897. No. 13330 C.

HYDRAULIC Pressure.

Experiments in Bursting a Boiler by Hydraulic Pressure. The boiler tested was built by the John O'Brien Boiler Works Co. of St. Louis, the object being to determine the strength of two different styles of rivetted joints. Ill. 350 w. Eng News—July 1, 1897. No. 13820.

INSPECTION.

Boilers as the Inspector Finds Them. George B. Hartley. Discusses the causes of explosions, the demand for high-pressure boilers, with consideration of various types of boilers, &c. Discussion follows. Ill. 5800 w. Pro Engs' Club of Phila—April, 1897. No. 13334 D.

SMOKE.

The Smoke Nuisance and Its Regulation with Special Reference to the Condition Prevailing in Philadelphia. Discussion at meeting of the Franklin Institute. 8500 w. Jour Fr Inst—June, 1897. No. 13284 D.

WATER TUBE Boiler.

See same title under Marine Engineering.

COMPRESSED AIR.

AIR Compressor.

High-Pressure Air Compressor and Receiver

for the Hardie Locomotive. Views and description of the air-compressor and the receiver or storage reservoir which provide and maintain the supply of compressed air. 800 w. Am Mach—June 10, 1897. No. 13370.

Hydraulic Air-Compressing Plant. C. H. Taylor. Extract from a paper read at meeting of Mining Engineers in Montreal. The compression was effected by the flow of water down a vertical pipe, the air being collected in a receiver. Ill. 2400 w. Eng, Lond—June 11, 1897. No. 13617 A.

Notes on Air Compressors. Robert Peele. An article intended particularly for the use of students in mining engineering. Part first treats of the general structure of compressors, the compression of air, wet compressors, dry compressors, piston clearance in air cylinders, and compound or stage compression. Ill. 8500 w. Sch of Mines Quar—April, 1897. Serial. 1st part. No. 13453 D.

The Philadelphia Compound Air Compressor. Illustrated description of the principal features of the new compound air compressor built by the Philadelphia Engineering Works. 1800 w. Ir Age—June 17, 1897. No. 13456.

COMPRESSED AIR Locomotive.

See same title under Street and Electric Railways.

HIGH ALTITUDES.

The Use of Compressed Air at High Altitudes. W. W. F. Pullen. A few notes on the results of the application of the air compressor at high altitudes. 1200 w. Prac Eng—May 28, 1897. No. 13360 A.

LIQUEFIED Air.

Compressed and Liquefied Air. Leland L. Summers. A consideration of the application of elementary principles of physics to this subject, and the prospect of increasing the economy of compression. 1800 w. Elec Engng—July 1, 1897. No. 13773.

MINING.

The Use of Compressed Air for Mining Purposes. Edward A Rix. A lecture delivered to the engineering students of the Leland Stanford, Junior, University. Considers the proper conditions under which to compress and use air, and the requirements of a modern air compressor, and the compressed air motor. Thinks this the only system which is alone sufficient to supply all the power needs of an average mine. 8500 w. Elec Engng—June 15. 1897. No. 13302.

ENGINES AND MOTORS.

DYNAMOS.

Modern Ideas in Dynamo Construction. (Neuere Anschauungen in Dynamobau) Discussing the influences of material, winding and general proportions in the light of recent experience. 5000 w. Zeitschr d Ver deutscher Ing—May 22, 1897. No. 13502 B.

On Dynamos. W. M. Mordey. Read before the Institution of Elec. Engs. The development of the dynamo and a discussion of its value and means of improving dynamos. Ill. 5300 w. Elect'n—May 28, 1897. Serial. 1st part. No. 13346 A.

The Problem of the Small Air-Space Dynamo. H. B. Atkinson. Discussing a paper by W. M. Mordey on Dynamos. 1800 w. Elect'n—June 11, 1897. No. 13625 A.

ELEVATOR Engines.

A Comparison Between Vertical and Horizontal Cylinder Hydraulic Elevator Engines W. S. Huyette. Part first notes the things to be considered in selecting the type of engine best adapted for a specified purpose, with account of test and description of a vertical cylinder engine. Diagram. 2200 w. Power—July, 1897. Serial. 1st part. No. 13782.

GAS Engines.

Gas Engines. W. F. Kelly. Read before the Engineers Club, Columbus, O. Brief reference to the earlier types showing the developments to the present successful type, with consideration of the theory upon which the gas engine operates. 4400 w. St Ry Rev—June 15, 1897. No. 13489 C.

MOTORS.

Shunt Motors for Car Propelling. (Zur Frage der Nebenschlussmotoren für Bahnbetrieb.) Claiming a higher efficiency and steadier motion, together with better commercial results for the shunt motor. 1500 w. Elektrotechnische Zeitschr—May 27, 1897. No. 13574 B.

Single-Phase Motors. Ernst J. Berg. Discusses the different types and their disadvantages. 1500 w. Am Elect'n—June, 1897. No. 13386 C.

PELTON Motor.

An Efficiency Surface for Pelton Motor. W. Kendrick Hatt. Paper presented to Indiana Academy of Sciences. A mathematical study. 700 w. Jour Fr Inst—June, 1897. No. 13287 D.

PUMPING Engine.

A Curious Pumping Engine at the Ridgewood Pumping Station of the Brooklyn, N. Y., Water Works. Illustrated detailed description. 1500 w. Power—July, 1897. No. 13781.

QUADRUPLE Expansion.

The Economy of Quadruple Expansion Engines. Arthur O. Druhsler. Describes the anti-vibration system and investigates the economy of this class and their ability for practical working Diagrams. 1300 w. Ind Engng—May 1, 1897. No. 13282 D.

STEAM TURBINE.

See Electrical Engineering, Power.

The de Laval Steam Turbine. (Die de Laval'sche Dampfturbine.) Illustrated description of the de Laval steam turbine, especially as applied to dynamo driving. 3500 w. Die Elektrizität—June 5, 1897. No. 13569 B.

POWER AND TRANSMISSION.

BELTING.

Rules Governing the Width of Leather Belting. J. J. Flather. Considers the problems of belting, the things to be considered in determining the size of belt, tests of strength, durability, cost, and related matters. 3500 w. W Elec—June 12, 1897. No. 13417.

CABLEWAY.

Cableway for Transportation of Millstone. (Chemin de Fer Aérien pour le Transport de Pierres Meulières.) An account of the overhead cableway at Barzy. The distance is 3450 feet, with a difference in level of 456 feet ; 300

tons of stone are transported in 10 hours. 2500 w. La Revue Technique—May 25, 1897. No. 13543 D.

GENERATING Plant.

Should Generating Plant be Mounted on Springs? James Swinburne. Remarks and brief discussion at Civil Engineers' Conference. 1600 w. Elec Eng, Lond—May 28, 1897. No. 13291 A.

MILLS.

Loss of Power in Mills. M. W. Danielsen. Calls attention to conditions that affect belts and so cause loss of power, and suggests remedies. Ill. 1400 w. Age of St—June 5, 1897. No. 13299.

PULLEYS.

Step or Cone Pulleys. Samuel Webber. Explains how to determine the diameter of a set of step or cone pulleys when a number of different speeds are constantly required. 1000 w. Clay Rec—June 14, 1897. No. 13643.

TRANSMISSION.

See Electrical Engineering, Power.

The Transmission of Power. William Henry Preece considers its transmission by electricity, Edward Bayzand Ellington, by water, and John Hopkinson all other methods, in papers read before the Civil Engineers' Conference, and these are discussed by the members. 5500 w. Elec Eng, Lond—May 28, 1897. No. 13290 A.

WATER Power.

The Control of Unused Water Rights. (Ueber die Frage des Heimfalles von Verliehenen Wasserrechten.) An official investigation into the value and ownership of numerous water rights in Austria, with an interesting technical discussion as to the value and availability of water power in general. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—May 21, 1897. No. 13515 B.

The Limitations of Government in Water-Power Plants. Mark A. Replogle. Names and briefly discusses the factors which determine the speed of a water-wheel. 1000 w. Min & Sci Pr—June 5, 1897. No. 13372.

WATER WHEELS.

A Study in the Replacement of Water-Wheels. (Studie über Auswechslungen von Wasserrädem bei Bestetienden Wasserwerken.) A discussion of the data to be taken into consideration when replacing the wheels in an existing plant by those of another construction; with a practical example. 1500 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13531 D.

Hurdy-Gurdy or Tangential Water-Wheels. Philip R. Bjorling. Illustrated description of these wheels and the manner in which they are regulated. 2000 w. Col Guard—June 4, 1897. No. 13414 A.

Impulse Water-Wheel Experiments. E. A. Hitchcock. Explains the theoretical action of the wheel, and reports experiments carried on in the Ohio State University laboratory. 1000 w. Elec Wld—June 5, 1897. No. 13324.

WINDMILLS.

Results of Windmill Tests. E. C. Murphy. Tests made during the summer of 1896, on large steel mills working large pumps and raising water for irrigating purposes. 1400 w. Kan Univ Quar—April, 1897. No. 13473 D.

SHOP AND FOUNDRY.

ARMATURES.

The Construction of Armature Coils. William Baxter, Jr. Explains methods of construction and forms, with illustrations. 1700 w. Am Mach—July 1, 1897. No. 13779.

BEARINGS.

Machinery Bearings of Aluminum. F. A. Farnsworth. Experiments showing that aluminum bronze need not be a failure as a bearing metal. Ill. 700 w. Am Mach—June 24, 1897. No. 13657.

BRASS.

Aluminum, Manganese and Silicon in the Brass Foundry. F. J. Davis. Read at the convention of the American Foundrymen's Assn., at Detroit. Discusses the advantages of each metal. 1400 w. Ir Trd Rev—June 24, 1897. No. 13678.

Gating Small Patterns for Brass. C. Vickers. An endeavor to point out the best way to gate patterns from which brass castings are to be made, so as to produce the greatest percentage of good castings with the least expenditure of time on the part of the moulder. Ill. 1300 w. Am Mach—June 24, 1897. No. 13655.

CAST Iron.

Malleable Cast Iron. George Parker Royston. An account of the investigation carried out by the author on the manufacture of malleable cast-iron. 3400 w. Prac Eng—May 28, 1897. No. 13361 A.

COMMUTATORS.

Making and Repairing Commutators. L. C. Sharpe. Drawing and explanation of how to put up a repair-shop commutator. 1800 w. Am Mach—June 24, 1897. No. 13656.

DIES.

Bending Dies for Press Work. J. L. Lucas. Illustrated description of three dies for this class of work. 500 w. Am Mach—June 24, 1897. No. 13654.

ELECTRICAL Machinery.

Electrical Machine Shop Practice. James F. Hobart. The first of a series of articles giving a description of shop practice as exemplified in the construction of electrical machinery. 1000 w. Elec Eng—June 23, 1897. Serial. 1st part. No. 13713.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. Cost-reduction and labor-saving by electric applications. Ill. 3200 w. Eng Mag—July, 1897. Serial. 2d part. No. 13810 B.

FACINGS.

Foundry Facings. H. F. Frohman. Read at Chicago meeting of Western Foundrymen's Assn. Discusses different kinds of facings for different kinds of work. 2000 w. Age of St—June 19, 1897. No. 13622.

FLANGING

Hydraulic Flanging Machine. Illustrated description of machine and method of operation. 1000 w. Am Mach—June 10, 1897. No. 13369.

MACHINE TOOLS.

Grinding Machines and Milling Machines for Locomotive Frames. (Schleifmaschine und Lokomotivrahmen Fräsmaschine.) Giving illus-

trations of the tools made by Collet & Engle-hard, of Offenbach a/M, and notable chiefly by the closeness with which they have followed American models. 5000 w. Zeitschr d Ver Deutscher Ing—June 5, 1897. No. 13506 B.

MANUFACTURING.

Manufacturing Methods as applied to the Production of Machinery. F. A. Halsey. Points out some of the means of maintaining dimensions and expediting work. The methods described relate specially to manufacture by aid of special fixtures, and refer to pure machine shop operations only. 3300 w. Sib Jour of Engng—June, 1897. No. 13421 C.

MILLING.

A Small Bench Milling Machine. A. H. Cleaves. Illustrated description of a bench milling machine that has been used to good advantage for many years in different shops. 1200 w. Am Mach—July 1, 1897. No. 13777.

Cast-Iron Milling Cutters. E. A. Gay. Description of milling cutters used by the Enterprise Foundry Co. of Rochester, N. Y., in the manufacture of butts and hinges, with illustrations of samples made with these tools. 1500 w. Am Mach—July 1, 1897. No. 13778.

MOLDING.

Molding Chemical Pans. George O. Vair. Drawings with description of a casting made by a process termed "skin-drying." 700 w. Am Mach—July 1, 1897. No. 13780.

PLANER.

How the Planer Was Driven. John Randol. Describes the drive of a planer in the Builders' Iron Foundry Machine Shop, Providence, R. I. 1200 w. Am Mach—June 17, 1897. No. 13-469.

STEEL Pulley.

An All-Wrought Steel Pulley. Edward G. Budd. Describes an ordinary belt-wheel made entirely of steel and representing the highest development of the sheet metal workers art. Ill. 1500 w. Jour Fr Inst—June, 1897. No. 13-286 D.

MISCELLANY.

BICYCLES.

Some Comments on the Essentials of Bicycle Design. E. H. Erhman. Discusses points in design and new features, giving special attention to bearings, driving gear and frame. Ill. 6000 w. Technic—1897. No. 13765 D.

COLLEGE.

A German Technical College from an English Point of View. Edwin O. Sachs. Deals principally with the architectural section and the courses available for students, with some historical and descriptive notes. 3000 w. Brit Arch—June 18, 1897. No. 13738 A.

DREDGING.

Pioneers of Centrifugal Pump Dredging. Letter to the editor from Frank E. Lesourd, criticizing the claims to inventions made by A. W. Von Schmidt and A. B. Bowers, with replies from the parties criticized. 5500 w. Eng News—June 17, 1897. No. 13488.

GEAR Teeth.

The Strength of Gear Teeth. John H. Barr. A study of the subject by the writer with results. 1000 w. Sib Jour of Engng—June, 1897. No. 13422C.

GRAPHOSTATICS.

The Internal Forces in a Framed Ring, Graphically Determined. (Die Innern Stabkräfte eines Belasteten Fackwerkringes, Graphisch Ermittelt.) An excellent graphostatic investigation of a framed ring using the cord- and force-polygon method. 3500 w. Schweizerische Bauzeitung—May 15, 1897. No. 13535 B.

HEAT Equivalent.

The Bakerian Lecture.—On the Mechanical Equivalent of Heat. Osborne Reynolds. Abstract of lecture before the Royal Society. Research to determine the mechanical equivalent of the total heat necessary to raise the temperature of water over the standard interval of temperature, and thus to obtain directly the equivalent of the mean specific heat between the freezing and boiling points. 1500 w. Nature—June 3, 1897 No. 13431 A.

MEASUREMENT.

The Decimal System in Engineering Measurement. Henry Riall Sankey. Read at Civil Engineers' Conference. Considers the advantage of the metric system and reports the results of its introduction into the works of Messrs. Willans and Robinson. Short discussion. 2000 w. Elec Eng, Lond—May 28, 1897. No. 13293 A.

MICROTOMES.

On Two Forms of Automatic Microtomes. Charles Sedgwick Minot. Describes the automatic wheel microtome, and the precision microtome; also a new form of microtome knife. Ill. 4500 w. Science—June 4, 1897. No. 13288.

MOTOR Cars.

Motor Cars at the Crystal Palace. An account of the entries and trial, in response to the prizes offered by this journal, with editorial comment. Ill. 6500 w. Eng, Lond—June 4, 1897. No. 13412 A.

The Present Status of Motor-Driven Vehicles for Common Roads. Editorial comment on the competitive trial planned by the London *Engineer*. 2300 w. Eng News—July 1, 1897. No. 13819.

NICKEL Plating.

Nickel Plating. Information relating to cleaning metals and nickel plating taken from a treatise published by the Zucker & Levett & Loeb Co. 4300 w. Ir Age—July 1, 1897. No. 13796.

PLANIMETER.

A New Moment Planimeter. (Ein Neues Momentenplanimeter.) A new form of planimeter by means of which the statical moment or the moment of inertia may be determined by mechanical integration. 3500 w. Schweizerische Bauzeitung—May 8, 1897. No. 13534 B.

SCHOOLS.

Preparatory Schools for Engineering Education. (Die Vorschulen für das Studium der Ingenieurwissenschaften.) A plea for better technical preparatory course than is at present given by the existing gymnasium, by Rector Schumann of the Realschule at Stuttgart. 5000 w. Zeitschr d Ver Deutscher Ing—June 5, 1897. No 13507 B.

The Relation of the Technical and Classical Schools in Karlsruhe. (Das Gutachten der Tech-

nischen Hochschule in Karlsruhe über die Oberrealschulen.) A contribution to the subject of education, which though local in its immediate allusions, shows very clearly the active discussion now going on throughout Germany for more practical education. 6000 w. Zeitschr d Ver deutscher Ing—June 12, 1897. No. 13508 B.

SKATING Rink.

Artificial Skating Rinks. (Künstliche Eislaufbahnen.) Illustrated description, with practical data, of artificial ice surfaces for skating, with especial reference to the rink at Nuremberg, 150x80 feet. 2500 w. Zeitschr d Ver deutscher Ing—June 12, 1897. No. 13509 B.

SPEED Indicators.

Speed Indicators and Recorders. (Tachometer und Tachographen.) Illustrating and describing Dr. Horn's improved apparatus. Two articles. 5000 w. Die Elektrizität—April 10, May 8, 1897. No. 13565 D.

TEXTILE Machinery.

The Textile Machinery in the exposition of 1896. (Die Maschinen der Textilindustrie auf den Ausstellungen des Jahres 1896.) Giving an illustrated account of the textile machinery shown at the Berlin exposition. Serial. 1st part. 5000 w. Zeitschr d Ver deutscher Ing—June 5, 1897. No. 13505 B.

WEDGE.

The Mechanical Advantage of the Wedge. W. W. F. Pullen. Showing the small mechanical advantage of the wedge. 900 w. Prac Eng—June 4, 1897. No. 13435. 30 cts.

MINING AND METALLURGY.

COAL AND COKE.

ALABAMA.

Coal and Iron in Alabama. William M. Brewer. A brief history of these industries is given as an introduction to a series of articles to be published in the same paper. 1400 w. Am Mfr & Ir Wld—June 25, 1897. Serial. 1st part. No. 13724.

BITUMINOUS Coal.

The Pennsylvania Coal Investigation. Editorial on the report of the committee appointed to investigate the condition of the coal trade in the bituminous districts of Pennsylvania. 1200 w. Eng & Min Jour—June 12, 1897. No. 13-404.

COAL.

The Treatment of Coal. Continuation of the discussion of the papers read before the Inst. of Civ. Engs. by Mr. James Rigg, on "Tipping and Screening Coal," and Mr. Thomas Gillott, on "The Surface Plant at Kirkby Colliery." A summary of the discussion by correspondence. 9300 w. Col Guard—May 28, 1897. No. 13-313 A.

COAL-WASHING.

Coal-Washing Installation at the Baltavara Mines (Asturias), Spain. Emilio Jimenez. Description with longitudinal and transverse sections. 1800 w. Col Guard—May 28, 1897. No. 13314 A.

Coal Washing. R. M. Hosea. A description of the Colorado Fuel and Iron Co.'s Washing at Sopris, Colo. The character of the coal, the advantages accruing from washing it, and the experiments which led up to the adoption of the present plant. 4000 w. Col Eng—June, 1897. Serial. 1st part. No. 13604 A.

ELECTRICAL Transmission.

On Electrical Transmission of Power in a Colliery. L. Gorchot. Translated from "Memoires de la Société des Ingenieurs Civils de France." A general account of a large electrical plant at a colliery in France, now in process of completion. 2800 w. Eng, Lond—June 11, 1897. No. 13619 A.

EXPLOSIONS.

Contributions to the Fire-damp Question. (Beiträge zur Schalagwetterfrage.) With especial reference to the relation of atmospheric conditions and the production of explosive gases in mines. 10000 w. Glückauf—May 8, 1897. No. 13578 B.

Remarkable Firedamp Explosion and Its Lesson. From a communication to *Glückauf*, by Berg ingenieur Lamprecht, Anina-Steierdorf, South Hungary. An account of the disaster and a study of the cause. 2200 w. Col Guard—June 18, 1897. No. 13727 A.

The Recovery of Coal Mines after Explosions. Mr. Garforth. Read before the Federated Institution of Mining Engineers. Submits a number of rules suggesting precautions to be taken by the manager before an accident, and rules for guidance after an explosion. 3200 w. Col Guard—June 11, 1897. No. 13612 A.

EXPLOSIVES.

The Use of Explosives in Coal mines. An order modifying the restrictions imposed by a previous order, with reference to the use of explosives in coal mines. 3000 w. Col Guard—June 18, 1897. No. 13726 A.

FUEL.

Methods of Fuel Analysis. A review of a work by G. Arth, with extracts showing its practical nature. 2000 w. Col Guard—June 4, 1897. No. 13413 A.

The Heating of Boilers with Pulverized Coal (Le Chauffage des Chaudières au Charbon Pulvérisé.) Describing and illustrating the Ruhl system applied to a double flue boiler. 1000 w. La Revue Technique—May 25, 1897. No. 13-546 D.

HEATING Power.

Determination of the Heating Power and Steam-Producing Value of Coals from a Preliminary Examination. William Thompson. Read before the Can. Elec. Assn. Discusses a method whereby the heating power, and consequently the value of any fuel, can readily be determined. 2500 w. Can Elec News—June, 1897. No. 13478.

INUNDATION.

The River Level Colliery Inundation. Offi-

cial reports of J. T. Robson and Robert Woodfall on the circumstances attending the inundation which took place at Abernant, December 9, 1896. 2400 w. Col Guard—June 11, 1897. No. 13615 A.

MACHINERY.

Electric Mining Machinery. Fred J. Platt. Read before the Anthracite Coal Operators' Assn. Some facts in regard to its successful use, efficiency, superiority over old methods, its adaptability to various portions of the workings, and the comparative cost of operation. 4000 w. Col Eng—June, 1897. No. 13606 C.

MACHINE Mining.

Machine Coal Mining in Iowa, U. S. A. Foster Bain. Read before the Federated Institution of Mining Engineers. Describes methods of mining and machines used. 3300 w. Col Guard—June 11, 1897. No. 13614 A.

POT-HOLES.

Pot-Holes and the Mt. Lookout Cave. William Griffith. Read at the annual meeting of the Anthracite Coal Operators' Assn. Describes the formation, and the mine accidents caused by these phenomena. 1700 w. Eng News—June 24, 1897. No. 13685.

PRODUCTION.

United States Coal Production in 1896. Tables giving statistics of the total production of coal and coke in the United States for 1896, as collected for *The Mineral Industry*, with comments. 1800 w. Eng & Min Jour—June 19, 1897. No. 13492.

SPONTANEOUS Combustion.

Spontaneous Combustion of Coal Cargoes. Conclusion of the Royal Commission appointed by the Government of New South Wales to inquire into the causes of the firing of coal cargoes, as given in their report. 1300 w. Aust Min Standard—May 13, 1897. No. 13720 A.

TRANSVAAL.

Notes on the Coal Seams of the Transvaal, and Description of a Modern Pit Head Plant. W. T. Hallimond. Describes the conditions under which the seams are found, and the plant erected at the Rand Collieries. 1600 w. Ir & Coal Trds Rev—June 18, 1897. No. 13728 A.

UNDERGROUND Fire.

Underground Fire at Bridgewater Colliery. A. Dury Mitton. Read before the Federated Institution of Mining Engineers. Describes the conditions and the mode of conquering the fire, with the difficulties. 2800 w. Col Guard—June 11, 1897. No. 13613 A.

COPPER.

ARSENIC.

Notes on the Estimation of Arsenic in Copper. George L. Heath. Suggestions concerning a method, from the writer's experience found suited to high-grade refined metal. 1000 w. Eng & Min Jour—June 26, 1897. No. 13692.

COPPER.

Tools and Weapons of the Age of Pure Copper in Egypt. (Outils et Armes de l'Age du Cuivre Pur en Egypte.) An interesting communication by M. Berthelot concerning the chemical analysis of some very ancient tools, with surmises as to the method of their production. 2500 w. Comptes Rendus—May 24, 1897. No. 13554 D.

METAL Mines.

Characteristic American Metal Mines. Titus Ulke. Describing the Anaconda copper mine and works. Ill. 4600 w. Eng Mag—July, 1897. Serial. 1st part. No. 13805 B.

NICKEL.

Modern American Nickel Refining. Titus Ulke, in the *Zeitschrift fur Electro chemie*. Consideration of the methods in use, which are claimed to be superior to the European methods. Abstract with diagrammatic scheme of the Orford method of treating nickel-copper matte. 1800 w. Eng & Min Jour—July 3, 1897. No. 13823.

GOLD AND SILVER.

ARIZONA.

The Fortuna Gold Mine, Arizona. William P. Blake. Description of mine and manner of working. 1200 w. Eng & Min Jour—June 26, 1897. No. 13693.

The Mines of Yavapai County, Arizona. John P. Blandy. Descriptive account of the mineral wealth of this district. Map. 2600 w. Eng & Min Jour—June 19, 1897. No. 13495.

The Pearce Mining District, Arizona. F. M. Endlich. Describes this rich mine, and the interesting conditions surrounding it. 1100 w. Eng & Min Jour—June 5, 1897. No. 13276.

BLACK Hills.

The Metallurgy of the Refractory Gold Ores of the Black Hills of South Dakota. Frank Clewes Smith. Brief review of the source of these ores, their discovery and process of treatment. 3400 w. Technic—1897. No. 13767 D.

COLOMBIA.

Explorations in the Gold Fields of Western Colombia. F. C. Nicholas. Read before the N. Y. Academy of Sciences. Investigations of the country leading the writer to believe that the general deposits of gold are not one-tenth part of what might be expected from the reports of certain findings, but due to the gold becoming concentrated in depressions and along zones of drainage. 3300 w. Sch of Mines Quar—April, 1897. No. 13455 D.

COLORADO.

Some Mineral Veins of Gunnison County, Colorado. E. R. Warren. Describes veins that may become of considerable economic value. The ores are usually a mixture of galena blende and pyrite, with some silver and gold. 1500 w. Eng & Min Jour—June 12, 1897. No. 13405.

CYANIDING.

Cyaniding Gold Ores. H. Rosales. Explains the nature of cyanogen and of cyanide of potassium, their value and adaptability as solvents of gold from auriferous ores, and describes in detail the method and treatment. 8400 w. Aust Min Stand—April 22, 1897. No. 13340 A.

Precipitation of Gold from Cyanide Solutions. L. Ehrmann. From Trans. Chem. and Met. Soc., Johannesburg. Describes experiments made giving results. Discussion follows. 2500 w. Min & Sci Pr—June 19, 1897. No. 13707.

EXTRACTION.

The Extraction of Gold from Kalgoorlie Ores. Walter J. Studds. A comparison of percentage

extraction and cost by smelting with that by battery amalgamation, concentration, and cyanidation. 2000 w. Aust Min Stand—April 29, 1897. No. 13341 A.

FISSURE Veins.

Filling and Replacement in Gold-Bearing Fissure Veins. Waldemar Lindgren. Considers the alterations of the country rock in and near the fissure veins, the silicification, and the structure of the veins. 1600 w. Eng & Min Jour—June 5, 1897. No. 13277.

GEORGIA.

The Cartersville Mining District, Georgia. William M. Brewer. A brief account of this district and the diversity of the mineral resources. 1000 w. Eng & Min Jour—June 5. 1897. No. 13278.

GOLD Field.

The Disputed Gold District of Brazilian Guiana. (Der Strittige Golddistrict von Brasilianisch Guyana.) A geographical and geological description, by Dr. Katzer, of Para. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 29, 1897. No. 13577 B.

The Lake of the Woods Gold-Field. T. A. Rickard. Discovery, prospecting, history, geology, gold-bearing veins, &c., are described. Ill. 3300 w. Eng & Min Jour—July 3, 1897. No. 13822.

ORE-Shoots.

Ore-Shoots of Cripple Creek. Arthur Lakes. Treats of their appearance, nature and shape, and how they differ from veins. Describes the peculiarities in some of the mines of Raven Hill, Gold Hill, Bull Hill, Battle Mountain and Beacon Hill. Ill. 2300 w. Col Eng—June, 1897. No. 13605 C.

PLACER Deposits.

Placer Prospecting. Arthur Lakes. Notes and suggestions for those starting to prospect for placer deposits. Ill. 5000 w. Col Eng—June, 1897. No. 13603 C.

RECEPTACLES.

Receptacles for Valuable Mineral Deposits. A study of receptacles and the importance to the miner in understanding how to work any deposit. 6000 w. Aust Min Stand—April 29, 1897. Serial. 1st part. No. 13342 A.

IBERIA.

Working Frozen Alluvial Deposits in Siberia. E. D. Levat. Describes the special methods of working where the ground is always frozen. Ill. 900 w. Eng & Min Jour—June 12, 1897. No. 13406.

SILVER-LEAD.

Heat Requirements of the Silver-Lead Blast Furnace. L. S. Austin. Investigation of this subject. 1000 w. Eng & Min Jour—June 19, 1897. No. 13496.

THE CAROLINAS.

The Genesis of the Gold Ores in the Central Slate Belt of the Carolinas. H. B. C. Nitze. Considers the structure of the deposits, the causes of the formation of the spaces occupied by the deposits, and the manner of filling these spaces. 2200 w. Eng & Min Jour—June 19, 1897. No. 13493.

VICTORIA.

The Steiglitz Goldfield, Victoria. William Bradford. Illustrated detailed description. 2000 w. Aust Min Stand—May 13, 1897. Serial. 1st part. No. 13719 A.

WITWATERSRAND.

The Witwatersrand Gold-Field and its Working. L. de Launay. Part first deals with the geology of the gold-field, giving maps and sections. 1300 w. Eng & Min Jour—June 19, 1897. Serial. 1st part. No. 13494.

IRON AND STEEL.

ALABAMA.

See same title under Coal and Coke.

ANALYSIS.

The Gas Volumetric Determination of Carbon in Iron and Steel. (Zur Gasvolumetrischen Bestimmung des Kohlenstoffes in Eisen und Stahl.) Describing an improved apparatus used in the laboratory of the technical High School at Brünn. 1 Plate. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 22, 1897. No. 13576 B.

CARBIDE.

Preparation of Carbide of Iron by the Direct Union of the Metal and Carbon. (Préparation du Carbure de Fer par Union Directe du Métal et du Carbone.) A communication by M. Moissan showing the conditions under which carbide of iron is produced in the electric furnace. 3000 w. Comptes Rendus—April 5, 1897. No. 13549 D.

CARBON.

Forms of Carbon, and the Hardening of Steel. (Kohlenstoff formen und Stahlhärtung.) Discussing the formation of Carbide of iron in connection with the hardening of steel. 2000 w. Stahl und Eisen—June 1, 1897. No. 13563 D.

CAST Iron.

See Mechanical Engineering, Shop and Foundry.

CHINA.

Iron Mines in China. Reprint of an article from the *North China Daily News*, giving a description of the iron and coal mines near Hankow, in Hupeh, of interest to those concerned in the railroad development of China. 1800 w. Cons Repts—June, 1897. No. 13649 D

CONVENTIONS.

Convention of the Eisenhüttenleute, and of the Iron & Steel Institute. (Die Haupt Versammlung des Vereins Deutscher Eisenhüttenleute und die Versammlung des Iron & Steel Institut.) A general report, from the German standpoint, of these two great conventions, with valuable tables and data. Two articles. 12000 w. Glückauf—June 5 & 12, 1897. No. 13583 E.

ELASTICITY.

The Elasticity of Steel. H. K. Landis. The main purpose of the paper is to point out an important error in the methods of determination of quality. 1800 w. Am Mfr & Ir Wld—June 18, 1897. No. 13647.

GRADING.

The Grading of Southern Coke and Charcoal Iron. The purpose of the paper is to point out the fallacies and show wherein the present system of grading, as practiced, lacks the uniformity and exactness which should be expected, and to urge the necessity of a standard based on chemical inspection. 1800 w. Tradesman—June 15, 1897. Serial. 1st part. No. 13607.

HIGH Temperatures.

Relation of Carbon to Iron at High Temperatures. Results from experiments made in the metallurgical department of Mason College, Birmingham, as given in a paper by G. P. Royston, read before the British Iron and Steel Inst. 700 w. Am Mfr & Ir Wld—June 25, 1897. No. 13723.

IRON-ORE.

Notes on the Iron-ore Resources of Different Countries. Part first gives an illustrated account of the resources of the United States. 1600 w. Ir & Coal Trds Rev—May 28, 1897. No. 13355 A.

ORDNANCE.

Iron and Steel for Ordnance. Facts taken from a paper read some years ago by Capt. Scott, before the Royal United Service Institution. Ill. 3600 w. Sci Am Sup—June 26, 1897. No. 13673.

MAGNETISM.

The Magnetic Properties of Modern Irons. (Ueber die Magnetischen Eigenschaften der Neueren Eisensorten.) Discussing the applicability of the Steinmetz coefficient to various commercial brands of iron. 3500 w. Stahl und Eisen—June 1, 1897. No. 13564 D.

The Steinmetz Coefficients of Magnetic Hysterisis. (Ueber den Steinmetz'schen Koefficienten der Magnetischen Hysteresis.) Applying the Steinmetz coefficients to a variety of modern irons. 3500 w. Elektrotechnische Zeitschr—May 13, 1897. No. 13570 B.

MICROSCOPICAL Examination.

Microscopical Examination of Iron and Steel. Albert Sauveur. Part first reviews the use of the microscope as an instrument of research in metallurgy, and the problems to be solved by chemical and microscopic examination. 2500 w. Eng & Min Jour—June 26, 1897. No. 13691.

NEW Works.

The New Works of the Apollo Iron & Steel Company. Illustrated detailed description of a model plant, possessing many features of novelty. 3000 w. Ir Age—June 17, 1897. No. 13458.

NICKEL Steel.

Investigations upon Nickel Steel. (Recherches sur les Aciers au Nickel.) Giving an account of the properties of an alloy of nickel and steel which has a very low coefficient of expansion besides other properties which make it especially adapted for standards of length. 1200 w. Comptes Rendus—April 5, 1897. No. 13550 D.

OPEN HEARTH Steel.

Combined Open Hearth Steel Manufacture. Benjamin Talbot. Description of process with results and impressions gained by practical experience in its use. 1800 w. Ir Age—June 17, 1897. No. 13457.

The Siemens and Siemens-Martin Processes. History of the development and the difficulties encountered, the changes and improvements in the methods of manufacture, changes in cost, &c. 3800 w. Ir & Coal Trds Rev—June 18, 1897. No. 13729 A.

ORE Supplies.

On the Iron Ore Supplies Available for the British Iron Trade. Josiah T. Smith. Paper read before the recent conference of the British Iron Trade Assn. Discusses the extent to which home supplies may be further utilized, and the sources of cheap and suitable ores from various countries. 3000 w. Ir & Coal Trds Rev—June 18, 1897. No. 13730 A.

SCANDINAVIA.

The Scandinavian Iron Ore Beds. (Ueber die Bildung der Skandinavischen Eisenerzlager.) A review, by Prof. Vogt of Christiania, of the geological and mineralogical conditions of the iron ore beds of the Scandinavian Peninsula. 5000 w. Glückauf—June 5, 1897. No. 13582 B.

SLAG.

Nitrosylized Blast Furnace Slag as an Addition to Hydraulic Cement. A. D. Elbers. Information regarding the efficiency and the treatment. 1300 w. Eng & Min Jour—June 26, 1897. No. 13690.

STEEL.

Steel as Viewed by the Engineer. P. Kreuzpointner. Discusses quality of structural steel, and methods of testing and inspection. Also discussion. 8800 w. Pro Engs' Club of Phila—April, 1897. No. 13335 D.

The Bertrand-Thiel Process. (Der Bertrand-Thiel Process.) A paper by Herr Thiel before the Düsseldorf Convention with an active discussion by various members. 8000 w. Stahl und Eisen—May 15, 1897. No. 13561 D.

The Bessemer Process. (Der Bessemer Process.) A review of the present status of the Bessemer process, presented at the Düsseldorf Convention by Herr Malz. 2500 w. Stahl und Eisen—May 15, 1897. No. 13559 D.

The Martin Process. (Der Martin Process). With details of gas producers, and a general account of present open hearth steel methods. By Herr Springorum, at the Düsseldorf Convention. 3500 w. Stahl und Eisen—May 15, 1897. No. 13560 D.

The Thomas Process. (Thomas Process.) A paper giving a general résumé of the Thomas Steel process, read by Herr Kintzlé at the Düsseldorf meeting of the Eisenhüttenleute. 6000 w. Stahl und Eisen—May 15, 1897. No. 13558 D.

STEEL Plates.

Witkowitz Steel Plates. A report of trial of these plates and the verdict, with observations and criticism. 2200 w. Eng, Lond—June 18, 1897. No. 13731 A.

STEEL Works.

Pittsburg Works of the Fox Pressed Steel Equipment Co. Illustrated detailed description of new works which are said to be the finest and most complete of their kind in this country. 1500 w. Ry Rev—June 5, 1897. No. 13296.

TIN PLATE.

The Tin Plate Industry in the United States. Ira Ayer. An account of the rapid growth of this industry since 1890, and much interesting information concerning the difficulties met and conquered. Also a tabulated statement of production in the United States, for each year since 1892. 6500 w. Jour Fr Inst—June, 1897. No. 13285 D.

VANADIUM.

The Alloys of Vanadium. (Les Alliages de Vanadium.) An account of the process of M. Helouis for the production of an alloy vana-

dium, aluminium and sodium, for use in the metallurgy of iron and steel. 1000 w. La Revue Technique—May 25, 1897. No. 13548 D.

WROUGHT Iron.

Wrought Iron and Mild Steel. A. Humboldt Sexton. Discusses what is malleable iron, and what is mild steel, their points of resemblance and difference, why mild steel has so largely displaced iron, and why iron is still preferred for some purposes. 5500 w. Prac Eng—June 18, 1897. No. 13740 A.

MINING.

ADDRESS.

Presidential Address of Mr. Lindsay Wood. Address before the Federated Institute of Mining Engineers, London. Discusses the influence of mining and engineering institutes, the advancement made in the science of mining, etc. 4300 w. Ir & Coal Trds Rev—June 4, 1897. No. 13402 A.

COMPRESSED AIR.

See "Mining" under Mechanical Engineering, Compressed Air.

DEEP Shafts.

The Deepest Shafts in the Earth. (Die Tiefsten Schächte der Erde.) Giving a table of the notably deep shafts in various parts of the world. 600 w. Glückauf—May 22, 1897. No. 13580 B.

MINING.

Papers Read at the Engineering Conference in London. "Dealing with Water in Pits during Sinking and in Permanent Work," by John Bell Simpson; "Water in Deep Shafts," by Henry Davey; "On Deep Levels in Mining Practice in the United Kingdom," by Bennett H. Brough; and "The Kent Coal-field," by Robert Ethridge. 5500 w. Col Guard—May 28, 1897. No. 13315 A.

MISCELLANY.

ASPHALTITES.

The Uinta and the Uncompahgre Asphaltites of Utah. Extracts from monograph on these deposits by George Homans Eldridge, in the report of the Geological Survey are given, with remarks. 2500 w. Eng & Min Jour—July 3, 1897. No. 13824.

LADDERS.

The Strength of Ladders. Robert Gilman Brown. Describes tests made of ladders of the common "Bull" pine of the Sierra region. 800 w. Eng & Min Jour—June 12, 1897. No. 13408.

MAPPING.

Mining Maps for Working Use. (Grubenkarten für Erzbergbane.) A discussion of the proper surface and underground maps, with especial reference to the conditions of the Hungarian mines. Two articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 1 & 8, 1897. No. 13575 E.

PETROLEUM.

The Petroleum Fields of Roumania. (Les Pétroles de Roumania.) A description of the petroleum fields as yet very imperfectly worked or developed, with some account of the geological formation in which they occur. 1500 w. La Revue Technique—May 10, 1897. No. 13539 D.

RUBY MINES.

The Ruby Mines of Burma. T. Trafford Wynne. Extract from a paper recently read before the Institution of Mining and Metallurgy in London, giving account of climate, labor, formation, exploitation, and methods of mining. 2000 w. Eng & Min Jour—June 12, 1897. No. 13407.

TIN.

The Tin Deposits at Temescal, Southern California. Harold W. Fairbanks. Describes the geology of the district, the vein system and tin deposits. 1700 w. Am Jour of Sci—July, 1897. No. 13771 D.

Tin Mining in Tasmania. H. W. Ford Keyser. Abstract of a paper presented to the general meeting of the Federated Institution of Mining Engineers. Part first gives the early history of tin mining in Tasmania. 3300 w. Ind & Ir—June 11, 1897. Serial. 1st part. No. 13620 A.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ADDRESS.

Inaugural Address of C. Stafford Ellery, before the Incorporated Gas Institute at Bath, Eng. The address deals largely with local matters, presents the value of chemistry in the gas industry, discusses carburetted water gas, and the amount of light that can be obtained from a ton of coal by different methods, &c. 7500 w. Gas Wld—June 19, 1897. No. 13784 A.

ATMOSPHERIC Burner.

The Theory of the Atmospheric Burner, and Its Influence upon Incandescent Gas Lighting. Vivian B. Lewes. Experiments with results of researches into the phenomena of the Bunsen burner. Read before the Incorporated Gas Inst. at Bath. 7500 w. Gas Wld—June 19, 1897. No. 13788 A.

BENZOL.

Benzol and Its Value as an Illuminating Agent. (Das Benzol und Seine Bedentung als Leuchtstoff.) Discussing especially the value of benzol as an enriching material for poor gases. 6000 w. Glückauf—May 15, 1897. No. 13579 B.

The Importance of Benzol as an Illuminant. Dr. Kramer. Abstract of a communication to the Verein fur Gewerbefleiss. Discusses the recovery and purifying of benzol, and its value as an illuminant. 2400 w. Jour of Gas Lgt—June 22, 1897. No. 13775 A.

CALORIMETER.

The Junker Calorimeter. (Calorimètre Industriel Junkers.) An illustrated description of the Junker Calorimeter, by means of which the calorific power of a gas to be used for heating, or in a gas engine, may be readily and accurately

determined. 1200 w. Le Genie Moderne—June 1, 1897. No. 13538 B.

CARBURINE.

On Three Years' Use of Carburine as an Enricher. Joseph Davis. Read before the Incorporated Gas Inst. at Bath, Eng. Results of experience during the last three years in working the Maxim-Clark process. Describes apparatus and method of working it. Also discussion. 8000 w. Gas Wld—June 19, 1897. No. 13790 A.

DISTRIBUTION.

Gas Distribution in Relation to Modern Municipal Development. Thomas Canning. Read before the Incorporated Gas Inst. at Bath, Eng. Discusses the size of mains, the precautions necessary in view of the newer condition of street paving, electrolysis of gas pipes, &c. 4800 w. Gas Wld—June 19, 1897. No. 13794 A.

FLAMES.

Explosion Flames. Harold B. Dixon. Abstract of a lecture at the Royal Institution. Reviews the work of others and gives an account of his own experiments. 3000 w. Jour Gas Lgt—May 25, 1897. No. 13283 A.

The Cause of Luminosity of Hydrocarbon Flames. Wilfrid Irwin. Read at meeting of the Manchester Section of the Society of Chemical Industry. Combats Prof. Lewes' ideas, and gives experiment illustrating his own. 1600 w. Jour of Gas Lgt—June 15, 1897. No. 13677 A.

FUEL GAS.

Fuel Gas. Arthur Kitson. Discusses the methods of converting solid and liquid into gaseous fuel, cost, &c. 5000 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13665 D.

On Cooking by the Aid of Gas, and the Ventilation of Kitchens. William Sugg. Read at meeting of Incorporated Gas Inst. at Bath, Eng. Historical retrospect, with the advantages of use of gas in cooking. Discussion. 6000 w. Gas Wld—June 19, 1897. No. 13786 A.

The Failure of the Commercial Attempts to Supply Fuel Gas in the United States. F. H. Shelton. Read before the Western Gas Assn. A paper proposing to show that fuel gas as a whole in every case where tried has been a flat and total failure. Gives a brief account of all instances where it has actually been made and distributed in this country. Discussion. 21000 w. Am Gas Lgt Jour—June 7, 1897. No. 13345.

GASHOLDER.

Notes on the Construction, and Experience in the Working, of the Gadd and Mason Spiral-Guided Holder at the Chester Gas Works. Robert Hunter. Read before the Incorporated Gas Inst., at Bath, Eng. A statement of reasons for adopting this holder, and experiences in its working during the past four years. 2700 w. Gas Wld—June 19, 1897. No. 13787 A.

The Inversion of an Untrussed Gasholder Crown. An account of an interesting operation in gasholder construction now in progress at the South Metropolitan Gas Company's Old Kent Road Station. 1700 w. Jour of Gas Lgt—June 15, 1897. No. 13676 A.

The Large Treble Lift Gasholder at the Bradford Road Gas Works, Manchester, Eng. Illustrated description. 800 w. Jour Gas Lgt—June 8, 1897. No. 13465 A.

INCANDESCENT Gas Lighting.

The Theory of Incandescent Gas Lighting. Abstract translation of an article by Dr. Moscheles, published in the "Zeitschrift für Beleuchtungwesen," on the cause of the intense development of light by Welsbach mantles in a gas flame. 1000 w. Jour Gas Lgt—June 1, 1897. No. 13350 A.

INCLINED Retorts.

An Additional Chapter on Inclined Retorts. Frederick Egner. Information concerning results with the sloping retorts. 2400 w. Am Gas Lgt Jour—June 21, 1897. No. 13627.

LEAKAGE.

Leakage. E. H. Jenkins. Read before the Western Gas Assn. Careful consideration of the subject, followed by discussion. 11000 w. Am Gas Lgt Jour—June 14, 1897. No. 13433.

MEASUREMENTS.

Calibration of a Pitot Tube in Gas Measurements. Forrest M. Towl. Illustrated description of tests and manner of using the tube, with tables. 1600 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13668 D.

MUNICIPALIZATION.

Is the Municipalization of Gas Undertakings Advantageous? Herbert Lees. Read before the Incorporated Gas Inst., at Bath, Eng. Concludes that under present circumstances it is not to the advantage of the consumer. Discussion. 9500 w. Gas Wld—June 19, 1897. No. 13793 A.

NAPHTHALENE.

Naphthalene in Modern Gas Manufacture, and the Carburetting of Illuminating Gas. William Young and Thomas Glover. Read before the Incorporated Gas Inst. at Bath, Eng. An account of the methods hitherto employed in reference to naphthalene, and an account of the new methods devised by the authors. 4500 w. Gas Wld—June 19, 1897. No. 13789 A.

PRESSURE Regulation.

The Automatic Regulation of Pressure in the Distributing Mains. William Reginald Chester. Read before the Incorporated Gas Inst., at Bath, Eng. Describes the apparatus invented by William Cowan and the satisfactory working. Discussion. 6500 w. Gas Wld—June 19, 1897. No. 13791 A.

PURIFICATION.

On Experiments with the Claus System of Purification at Belfast. James Stelfox. Read before the Incorporated Gas Inst., at Bath, Eng. Reports the trial of the system on a large scale and the failure. Discussion. 8800 w. Gas Wld—June 19, 1897. No. 13785 A.

STREET Lighting.

The Welsbach Incandescent Gas Light for Utility and Economy in Street Lighting. H. Wilkiemeyer. Read before the Western Gas Assn. Report of the success attained, with discussion and correspondence. 7000 w. Am Gas Lgt Jour—June 14, 1897. No. 13434.

TAXATION.

The Taxation of Gas by Local Authorities. Isaac Carr. Read before the Incorporated Gas Inst., at Bath, Eng. On the system of applying gas profits to the relief of local rates. 3300 w. Gas Wld—June 19, 1897. No. 13792 A.

SEWERAGE.

INFILTRATION.

Infiltration of Ground Water into Pipe Sewer Systems. Prepared from a Thesis by F. S. Senior. An attempt to throw some light in an experimental way, upon the question of what is a fair amount of infiltration to be expected from the joints of sewer pipe laid in water, before the cement has well set. 3500 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13671 D.

PRECIPITATION.

Excessive Precipitation in the United States. Alfred J. Henry. Extract from the "Monthly Weather Review," Jan. 1897. Valuable table of facts concerning excessive rain during 1896 with other information. 1500 w. Eng News—June 24, 1897. No. 13681.

PURIFICATION.

The Purification of Waste Water. (Mittheilung über die Reinigung der Fabriks-Abwässer.) Describes simple form of sedimentation, purification and filtration plant, by means of which the discharge water from manufacturing establishments may be purified before discharge into streams. 1 plate. 2500 w. Oesterr Monatschr f d oeffent Baudienst—May, 1897. No. 13526 D.

SEWERAGE.

The Best Method of Sewage Disposal on Farms and in Small Communities. B. C. Brett, in the *Medical Age*. Suggestions easily carried out at small cost, and, with proper attention, insuring health and cleanliness. 2200 w. Sci Am Sup—June 26, 1897. No. 13674.

The Paris Sewage System. (Die Entwässerung von Paris.) A discussion of the Paris sewers in comparison with those of Berlin, especially with regard to the sewage farms. Two plates. 8000 w. Oesterr Monatschr f d Oeffent Baudienst—May, 1897. No. 13521 D.

The Sewers of Paris, and the Purification and Utilization of the Sewage. (Die Kanalisirung von Paris, soure die Reinigung und Benutzung des Kanalwassers.) Especially describing the recent work in connection with the sewage utilization at Gennevilliers, Clichy and Achères. 4500 w. Glaser's Anna en—May 15, 1897. No. 13512 D.

SEWER Joints.

The Effect of Imperfect Joints upon the Flow in Pipe Sewers. Prepared from a Thesis by G. D. Holmes. Experiments made with six-inch vitrified tile pipe, showing generally an increase of velocity with the smooth interior. 2500 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13670 D.

SEWER Pipe.

Notes on the Construction of Pipe Sewers. H. E. Riggs. On methods of construction, mode of handling certain perplexing problems and pipe laying. 4300 w. Technic—1897. No. 13763 D.

Sewer Pipe Tests. Charles E. Greene Describes tests made and gives results and conclusions. 1600 w. Technic—1897. No. 13761 D.

STREETS AND PAVEMENTS.

SIDEWALKS.

Specifications for Cement Sidewalk Construction. A. J. McPherson, in Journal of the Engineering Society of the School of Practical Science of Toronto. Abstract of specification. 800 w. Eng News—June 24, 1897. No. 13680.

WOODEN Pavement.

Wooden Pavement and Public Health in Paris. Describes the construction and comments on the sanitary excellence. 1400 w. San Rec—June 11, 1897. No. 13624 A.

WATER SUPPLY.

ARTESIAN Wells.

Artesian Tube Wells. J. E. Discusses the work of tube lining and subsequent discharge. Ill. 1800 w. Ind Engng—May 15, 1897. No. 13476 D.

BIRMINGHAM, Eng.

The New Birmingham Water-works. From the *Birmingham Daily Post*. Describes a visit of inspection made by the City Council to these extensive works, now in process of construction. 2700 w. Arch, Lond—June 11, 1897. No. 13639 A.

CONSUMPTION.

Notes on Water Consumption. G. S. Williams. A study of the consumption in an American city considering the statistics mainly with reference to the quantity of water that must be provided at various times. 4000 w. Technic—1897. No. 13760 D.

DRILLED Well.

An Experience with a Drilled Well Adjoining Salt Water. James S. Haring. An account of an effort to obtain a new water supply, near Nyack, N. Y. The tests are given and the failure explained. 2000 w. Fire & Water—June 19, 1897. No. 13600.

FILTER Cleaning.

The Cleaning of the Open Filters at Hamburg in Time of Frost. (Die Reinigung der Hamburger Offenen Sandfilter in der Frostzeit.) An illustrated description of the Mager Scoop, by means of which the Hamburg filter beds are effectively cleaned when covered with ice. 6000 w. Gesundheits Ingenieur—May 31, 1897. No. 13532 B.

FILTRATION.

Increased Revenue, Free Service Pipes and Filtration. Dow R. Gwinn. Read before the convention of the American Water Works Assn. Describes the inducements offered to obtain customers, the manner and cost of laying service pipes, and the advantages of filtration. 1800 w. Fire & Water—June 12, 1897. No. 13432.

LONDON.

The London Water Supply. Percy F. Frankland. Extracts from a paper read before the Society of Arts. The value of bacteriology to the water engineer, an account of recent investigations in this field and the information collected, with special reference to the London supply. 4800 w. Jour of Gas Lgt—June 22, 1897. No. 13776 A.

METERS.

Value of Meters in Restricting Waste. L. N. Case. Extracts from address before the senate committee of the Michigan legislature to oppose the passage of the "free water bill." 1500 w. Fire & Water—June 26, 1897. No. 13733.

PUMPING Engine.
See Mechanical Engineering—Engines [and Motors.

PURIFICATION.
Purification of Water by Metallic Iron. C. W. Chancellor. A report of the iron process from the consul at Havre. 2400 w. Am Arch—June 5, 1897. No. 13359.

RESERVOIR.
The New Highland Reservoir, No. 2, Pittsburg, Pa. Plans and description of new reservoir built to save the expense of pumping the whole supply to unnecessary height, and to decrease the wear and tear on the mains. 1200 w. Eng Rec—June 19, 1897. No. 13,498.

SANITARY Sources.
Some of the Important Water Supplies of Europe Considered Mainly from a Sanitary Standpoint. James H. Fuertes. Interesting statistics concerning the water supplies of many European cities. 5700 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13664 D.

TOWNS.
Towns Water Supply and Its Distribution. W. M. Watson. The duty of supplying an abundance of good water, and many suggestions relating to the construction and care of the water supply. 4200 w. Can Eng—June, 1897. No. 13279.

TUNNEL.
Description of the Construction of the New Chicago Waterworks Tunnel. William G. Atwood. The building of a ten-foot tunnel, four miles into the lake. 2200 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13669 D.

TYPHOID Fever.
The Water Supplies of Eight Cities in Relation to Typhoid Fever Rates. John W. Hill. An address before the Soc. of Municipal Improvements, Chicaco, Ills., Oct. 9, 1896. Facts concerning four well-known cities of Europe and four well-known cities of the United States. 4400 w. San—June, 1897. No. 13451 D.

WATER Fermentation.
The Causes and Prevention of Water Fermentation. Samuel McElroy. Discussing the problem in the light of Brooklyn's experience with her water supply. 3300 w. Eng Mag—July, 1897. No. 13806 B.

MISCELLANY.

ABATTOIR.
The New Paris Abattoir. (Das Neue Schlachthaus der Stadt Paris.) A bird's-eye view and description of the new abattoir on the left bank of the Seine. About 25 acres of ground are included, and the abattoir has a capacity for about one-third the entire demand of the city. 1 plate. 1000 w. Oesterr Monatschr f. d Oeffent Baudienst—June, 1897. No. 13527 D.

LIGHTING.
Artificial Lighting. George D. Shepardson. An outline of the history of lighting with a study of illumination. 6500 w. Jour Assn of Engng Soc—May, 1897. No. 13663 C.

Municipal Lighting in the United States. F. W. Cappelen. Read at the meeting of Engineers' Club of Minneapolis. Information obtained from replies to a set of sixty-six questions sent out by a committee, with a few suggestions as to the best method of street lighting. 3500 w. Jour Assn of Engng Soc—May, 1897. No. 13662 C.

STREET Railways.
See "Municipal Ownership", under Street and Electric Railways.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

ASSAM-BENGAL.
Construction Work on the Assam-Bengal Railway. Francis Robert Johnson. Remarks referring to the section from Chittagong to Badarpur, the difficulties of construction being mentioned, but principally descriptive of the bridge work. 2000 w. Eng, Lond—June 11, 1897. Serial. 1st part. No. 13616 A.

BEHR System.
The Behr Monorail System. Brief history of the monorail systems, with description of the permanent way of the Behr system at Tervuren. Ill. 1800 w. Engng—June 11, 1897. Serial. 1st part. No. 13611 A.

CHINA.
Siberian Railway Extension in China. Information regarding the construction and working of the new line, which will give nearly 950 miles in Chinese territory. 2000 w. Eng, Lond—June 4, 1897. No. 13411 A.

ETNA.
The Circum-Etna Railway. Illustrated description of the railway round Mount Etna. 500 w. Eng, Lond—May 28, 1897. No. 13317 A.

INCLINE.
The Madison Hill Incline; P., C., C. & St. L. Ry. Edward Grafstrom. Historical sketch on the origin and development of engineering on the Madison Hill at Madison, Ind. Ill. 3600 w. Eng News—June 10, 1897. No. 13374.

LIGHT Railways.
Proposed Construction of Light Railways in Germany. Brief history of light railways to the present time with abstract of the new bill for the extension of the system. 900 w. Bd of Trd Jour—June, 1897. No. 13694 A.

VENEZUELA.
The Great Venezuela Railway. (Die Grosse Venezuela Eisenbahn.) The road, 112 miles long, between Caracas and Valencia, was constructed with great difficulty, mainly by German engineers and capital, at a cost of about $15,000,000. A full account of the engineering work is given. 7500 w. Glaser's Annalen—May 15, 1897. No. 13510 D.

MAINTENANCE OF EQUIPMENT.

BOX Car.
The Framing of a Box Car. George L. Fowler. An analysis of the stresses and their

distribution through the framing of a box car. 2200 w. R R Car Jour—June, 1897. No. 13362.

BRAKE.

The Westinghouse High-Speed Brake. Illustrated description. 2000 w. R R Gaz—June 25, 1897. No. 13700.

CAR.

The Schoen Steel Car. Brief description with illustrations. 800 w. R R Gaz—June 25, 1897. No. 13702.

CAR Heating.

Improvements in Steam Heating of Passenger Carriages on the Prussian Railways. (Neuere Anordnungen für die Dampfheizung der Personenwagen bei den Preussischen Staats-Eisenbahnen.) The improved system permits of moderate heating in mild weather or full heating in cold weather, with control of each compartment by the passengers. 6000 w. 1 plate. Glaser's Annalen—June 1, 1897. No. 13513 D.

CAR Lighting.

Electric Car Lighting from the Axle. Illustrated description of the construction and application of the system of direct cog wheel gearing from the axle to the dynamo. 900 w. Ry Rev—June 5, 1897. No. 13297.

The Electric Lighting of Railway Carriages. (Ueber Elektrische Beleuchtung von Eisenbahn Personenwagen.) A very thorough paper by Dr. Buettner, giving comparative results as to the cost of electricity as opposed to gas. 8000 w. Glaser's Annalen—May 15, 1897. No. 13511 D.

COAL Car.

Double Hopper 100,000-lb. Coal Car—Michigan Peninsular Car Co. Illustrated detailed description. 1200 w. Ry Rev—June 5, 1897. No. 13295.

COMBINATION Car.

Combination Passenger and Baggage Cars—Baltimore & Ohio. General dimensions and cuts showing in detail the framing and sections of first-class combination passenger and baggage cars. 1000 w. R R Gaz—June 4, 1897. No. 13307.

COUPLERS.

Uncoupling Arrangements for M. C. B. Automatic Couplers. Report from the committee, submitted at the Master Car Builders' Convention at Old Point Comfort. Ill. 1000 w. Ry Rev—June 19, 1897. No. 13658.

ERIE'S Train.

The Erie's New Through Train. Brief illustrated description of a fine train recently put in service on this road. 600 w. Loc Engng—June, 1897. No. 13331 C.

FIRE-BOX.

Locomotive Firebox Design. R. P. C. Sanderson. Personal experiences which have brought the subject before the writer's notice, with search for causes and knowledge gained. 3000 w. R R Gaz—June 11, 1897. No. 13381.

GONDOLA Car.

An Improvement in Gondola Car Construction. Diagrams showing a new method for the construction of gondola, coal, coke and other cars, where the sides are supported by stakes, now placed outside the sills. 600 w. Ry Mas Mech—June, 1897. No. 13272.

LOCOMOTIVES.

Experiments on a Compound Locomotive. Summarized translation by Bryan Donkin, from *Revue Générale des Chemins de Fer*. Dynamometric experiments on a four-cylinder express compound locomotive on the Paris, Lyons, and Mediterranean Railway, made by M. Privat in 1895. 1800 w. Engng—June 18, 1897. No. 13712 A.

Locomotive Improvement. Leonard J. Todd. Presents the advantages of the "dual exhaust" cylinder and claims a saving of 10 per cent. could be gained. 3000 w. Eng, Lond—May 28, 1897. No. 13320 A.

New Ten-wheel Passenger Locomotive—Louisville Division, Illinois Central. Illustrated description with dimensions. 800 w. R R Gaz—July 2, 1897. No. 13817.

Some Michigan Central Locomotives. Describes engines designed by Robert Miller, one being built by the Schenectady Locomotive Works, and three at the Jackson shops of the Michigan Central. 1700 w. R R Gaz—June 11, 1897. No. 13380.

Ten-wheel Passenger and Fast Freight Locomotives—Chicago, Rock Island & Pacific Railroad. Data and illustrations in connection with these engines, which represent advanced locomotive design. 2000 w. Ry Rev—June 12, 1897. No. 13438.

The Use of High Steam Pressures in Non-Compound Locomotives. Dugald Drummond. From selected papers of the Institution of Civil Engineers. Describes tests made on the Caledonian Railway, to ascertain what increase of efficiency or economy is derived from raising the boiler pressure in non-compound locomotives. 3400 w. Eng News—June 10, 1897. No. 13377.

PRIVATE Cars.

Another Royal Train. Brief description of train prepared to convey the Queen from Windsor to Paddington on occasion of the long reign commemoration. 700 w. Ill Car & Build—June 11, 1897. No. 13641 A.

Private Cars. Duane Doty. Illustrated description of the De Beers private car and the car "Marion." 2000 w. R R Car Jour—June, 1897. No. 13363.

The Presidential Car. A. Richards. Suggestion for the decoration of the dining portion of the special car for the President. Ill. 500 w. R R Car Jour—June, 1897. No. 13367.

TRUCKS.

Metal Trucks for Cars of 100 000-Pounds Capacity. Description and drawings of trucks to be used under the metal cars being built for the Pittsburg, Bessemer & Lake Erie Railroad. Describes the Schoen, Fox, Kindl, Cloud, Vogt, and American Steel Foundry Company's trucks. Also editorial. 2500 w. Ry Mas Mech—June, 1897. No. 13271.

Standard Steel Truck—Mexican Central Railroad. Illustrated description of the peculiar features of the construction of a metal, diamond-frame truck designed by A. A. Robinson. 500 w. R R Gaz—June 4, 1897. No. 13305.

Steel Underframing for Freight Cars. Report of the committee submitted at the Master Car Builders' Convention. Ill. 3300 w. Ry Rev—June 28, 1897. No. 13734.

The Cloud Truck. Illustrated description of a new design consisting of a combination of plate steel side frames and malleable iron pedestals which are riveted thereto. 1400 w. Ry Rev—June 12, 1897. No. 13437.

The Present Standing of the Steel Truck. Editorial comment on design and cost. 1600 w. R R Gaz—June 4, 1897. No. 13311.

VESTIBULED Train.

The New Vestibuled Train of the Chicago, Burlington & Quincy. Illustrated description of train. The arrangement, finish and decoration of the interior is especially interesting. 1000 w. R R Gaz—June 4, 1897. No. 13308.

WHEELS.

Specifications and Guarantee for Cast-Iron Car Wheels. Report of a committee of the Master Car Builders' Assn. presented at the annual convention held at Old Point Comfort, Va. 2000 w. Eng News—June 10, 1897. No. 13379.

The Anticipation of Failure. George S. Hodgins. Considers the symptoms of a wheel malady which indicate a near approach to danger. 1500 w. R R Car Jour—June, 1897. No. 13364.

MAINTENANCE OF WAY.

CROSS Ties.

Note on the Preservation of Wooden Cross Ties. (Note sur la Conservation des Traverses en Bois.) An investigation of the economy to be realized by the use of various preservatives, based upon actual results obtained upon the French railways. 3000 w. La Revue Technique—May 10, 1897. No. 13542 D.

RAILWAY Works.

The London Works of the Great Central Railway. Illustrated description of the London structures of this road now in process of construction. 2000 w. Ry Wld—June, 1897. No. 13400 A.

STATION.

New Union Station at Montgomery, Ala. Brief illustrated description of the improved facilities for passengers and freight provided by the Louisville and Nashville Railroad. 500 w. Ry Age—June 4, 1897. No. 13322.

STEEL Rail.

The Development of the Steel Rail in the United States. H. G. Prout. Reviewing the history of the steel rail up to 1887. Ill. 4700 w. Eng Mag—July, 1897. Serial. 1st part. No. 13809 B.

SIGNALING.

SIGNALING.

Progress in Signal Engineering. Charles Hansel. Briefly reviews the early history of railways and the requirements to protect traffic, and the growth of the system, showing improvements to the present, and the effect upon the volume of traffic. Ill. 11300 w. Trans of Assn of Civ Engs of Cornell Univ—June, 1897. No. 13667 D.

Quadruple Block Signal System. (Einrichtung von Blocklinen mit Viertheiligen Streckenblockwerken.) A system for obtaining greater security against rear end collisions by doubling the number of blocks between trains. 2 plates. 6000 w. Oesterr Monatschr f d Offent Baudienst—June, 1897. No. 13530 D.

TERMINALS AND YARDS.

CAR Handling.

Handling of Foreign Cars at Large Terminals. Interesting remarks in regard to errors and abuses in connection with the handling of interchanged cars at terminals. Taken from report by W. E. Beecham, chairman of a committee of the Central Western Assn. of Car Service Officers, appointed to investigate this subject. 3000 w. Ry Age—June 18, 1897. Serial. 1st part. No. 13640.

TRANSFER Table.

Transfer Table at Huntington shops—Chesapeake and Ohio Railway. Illustrated description of a transfer table in which compressed air is the motive power. 600 w. Loc Engng—June, 1897. No. 13329 C.

TRANSPORTATION.

CAPE COLONY.

The Railways of Cape Colony. A very favorable report of earnings, with account of improvements to be carried out. 1800 w. Trans—June 4, 1897. No. 13418 A.

CHEAP Transportation.

Lessons from American Railroads as to Cheap Transportation. W. R. Stirling. A paper aiming to show to what extent and how American railways have lowered their rates for transportation, and thereby cheapened the cost of raw material and manufactured commodities. Read at the annual conference of the British Trade Assn 5300 w. Ir & Coal Trds Rev—May 28, 1897. No. 13353 A.

ELECTRICITY vs. Steam.

The Application of Electricity to Steam Railroads. Paul H. Brangs. Abstract of Paper read at convention of the Master Mechanics Assn. Advocates the electrical equipment of branch lines and the use of electricity in many special cases. 1200 w. Elec Wld—June 26, 1897. No. 13750.

ENGINE Performance.

The Adjusted Car-mile as a Basis for Engine Performance. An account of tests made by the Pennsylvania lines west of Pittsburg, to determine the resistance of cars in freight trains, and investigating the practicability of applying an adjustment to the *car-mile* measurement of engine performance. 1400 w. RR Gaz—June 4, 1897. No. 13304.

EXPRESS Trains.

Our Express Trains and Locomotives. Editorial on the progress made by our express trains, and the excellence of locomotives in the United States. 1200 w. Loc Engng—June, 1897. No. 13332 C.

FAST Runs.

The Chicago-Nashville Fast Run. A record of an excellent performance. 600 w. RR Gaz—June 4, 1897. No. 13306.

A Table of Fast and Unusual Runs. Interesting table from the work "Modern Locomotives" soon to be published. 2000 w. RR Gaz—June 11, 1897. No. 13382.

MISCELLANY.

APPLIANCES.

Primitive Railway Appliances. C. B. Fairchild. Historical account of some of the early

appliances, some of which have been successful and others failures, but showing the evolutionary process of development. Ill. 2000 w. St Ry Rev—June 15, 1897. Serial. 1st part. No. 13490 C.

CHINA.
See same title under Mining and Metallurgy, Iron and Steel.

CONVENTION.
Annual Convention of the American Railway Master Mechanics' Association. An account of the meeting at Old Point Comfort, Va., with abstracts of most of the committee reports. 10000 w. RR Gaz—June 18, 1897. No. 13471.

Needed Reforms in the Railway Mechanical Conventions. Editorial comment on the reforms needed in the Master Mechanics' Assn. and Master Car Builders Assn. 1600 w. Eng News—June 24, 1897. No. 13684.

The Master Car Builders' Association. Report of the meeting at Fort Monroe, with abstracts of addresses, discussions, &c. 2000 w. R R Gaz—June 18, 1897. No. 13472.

COUPLERS.
Automatic Car Couplers for English Railways. Editorial on the slowness of Great Britain in adopting automatic car couplers, with criticism of an editorial on the subject which appeared in a recent number of the London "Engineer." 1300 w. Eng News—June 10, 1897. No. 13376.

DISPATCHER.
The Duties and Discretionary Powers of a Train Dispatcher. H. A. Dalby. Extracts from a paper read before the annual meeting of the Train Dispatchers' Assn. The things necessary to make the best dispatcher. 1400 w. R R Gaz—June 25, 1897. No. 13703.

EMPLOYEES.
Railroads and Employees. F. H. Stark. Considers the relation of employees on railroads to the employer. 1200 w. R R Car Jour—June, 1897. No. 13365.

FREIGHT Station.
How to Manage a Freight Station. J. F. Youse. Read before the Assn. of Officers & Junction Agents of the Columbus, Hocking Valley & Toledo R. R. Suggestions. 1100 w. R R Gaz—June 4, 1897. No. 13310.

FREIGHT Trains.
Causes and Remedies for the Parting of Railway Freight Trains. Report of a Committee of the Master Car Builders' Assn. presented at the annual convention at Old Point Comfort, Va. 2200 w. Eng News—June 10, 1897. No. 13375.

GERMANY.
German Railway Working, 1895-96. Statistics taken from report issued by the Imperial Railway Department. 1200 w. Eng, Lond—May 28, 1897. No. 13316 A.

ILLINOIS.
The Railways of Illinois. Dwight C. Morgan. Diagrams showing in a graphical manner the railroad conditions of Illinois for the past 25 years, with explanatory remarks. 2000 w. Ry Age—June 4, 1897. No. 13321.

JAPAN.
Opportunities for the Car Builder in Japan and China. R. Van Bergen. Discusses the probability of demand for American rolling stock in China and Japan, and how to enter into business relations with safety. 2000 w. R R Car Jour—June, 1897. No. 13366.

LEGISLATION.
Railroad Legislation in Massachusetts. A review of the large amount of railroad legislation presented at the last session. 3000 w. R R Gaz—June 25, 1897. No. 13699.

Railroad Legislation in New York. Reviews the 15 bills affecting railroads, which have been passed during the past year. 1500 w. R R Gaz—June 25, 1897. No. 13701.

See same title under Street and Electric Railways.

SCANDINAVIA.
Notes on a Journey in Scandinavia. W. J. McCarroll. Gives information of the railroads of the country. 2400 w. Loc Engng—June, 1897. No. 13333 C.

TIME.
See same title in Marine Engineering.

TRANSCONTINENTAL Railways.
Profiles of Transcontinental Railways. Double-page engraving showing the comparative features of the several lines reaching the Pacific coast, with tables and description. 2200 w. Eng News—June 10, 1897. No. 13378.

STREET AND ELECTRIC RAILWAYS.

AIR-BRAKE.
The Howe Air-Brake for Electric Cars. Describes an air brake designed especially to meet the needs of electric street car service, but is equally applicable to cable service, and to other services running single cars or short trains. Ill. 1000 w. R R Gaz—June 4, 1897. No. 13309.

ALTERNATING Current.
See same title under Electrical Engineering, Power.

BOSTON Elevated.
The Boston Elevated Railroad. The important features of the new franchise which has recently been passed and approved by the governor, with comments by editor. Map. 2200 w. R R Gaz—July 2, 1897. No. 13816.

CAIRO, Egypt.
To the Pyramids by Electricity. Account of a projected tramway, and information of the popularity of the tramways of Cairo. Ill. 1000 w. St Ry Rev—May 15, 1897. No. 12956 C.

COMPRESSED AIR Locomotive.
The Hardie Compressed Air Locomotive for the Manhattan Elevated Ry. Illustrated detailed description. 1000 w. Eng News—June 24, 1897. No. 13683.

CONDUIT System.
The "Mapple" Hinged Conduit System. Illustrated description of a system for electric traction, in which the distinctive feature is found in the means provided for reaching the interior of the conduit without removal of the slot rails or disturbance of the paving of the

roadway. 1100 w. Ry Wld—June, 1897. No. 13401 A.

COUNTERWEIGHT System.

The Morgan Park Counterweight System. Illustrated description of various applications of this system. 2700 w. Ry Rev—May 22, 1897. No. 13111.

CURRENTS.

Stray Currents in Electric Tramways. (Zur Frage der Vagabunderen den Ströme bei ElektrischenBahnen.) A discussion of various means of reducing the losses due to the return current through the rails. 2500 w. Die Elektrizität—April 10, 1897. No. 12773 B.

DOVER.

The Dover Corporation Electric Tramways. Henry E. Stilgoe. Read before the Incorporated Assn. of Municipal and County Engs., at Dover. Illustrated detailed description. 2000 w. Elec Eng, Lond—May 7, 1897. No. 12941 A.

EARNINGS.

The Commercial Aspect of Electric Railways. C. E. A. Carr. Discusses modes of advertising, improvements, and ways of increasing the revenue. 1700 w. Can Elec News—June, 1897. No. 13480.

ELECTRICAL Equipment.

The Cost and Advantage of Electrical Equipment for Railways. John C. Henry. Gives the results of investigations for the electrical equipment of the Florence and Cripple Creek Railway. The equipment proposed is quite a departure from the ordinary street railway practice. 2000 w. Elec Eng—June 2, 1897. No 13241.

The Electrical Equipment of Steam Roads in Chicago. Illustrated detailed description of construction and equipment, with editorial. 3500 w. Ry Rev—June 19, 1897. No. 13659.

ELECTRICITY vs. Steam.

See same title under Railroad Affairs, Transportation.

ELECTRIC Railways.

Advice to Builders of Electric Railways. G. Whitefield Chance. Calls attention to important matters in the construction and operation of interurban roads. 1400 w. W Elec—June 5, 1897. No. 13349.

ELECTRIC Traction.

Electric Railroading on the New York, New Haven & Hartford System. N. H. Heft. An outline of what this company has been doing in its electrical department during the last three years. Ill. 4800 w. St Ry Jour—June, 1897. No. 13191 C.

Some Recent Developments in Electric Traction Appliances. A. K. Baylor. Read before the Inst. of Elec. Engs. Part first discusses the modern plant, considering generators, overhead line, ground returns, and the three-wire system. Ill. 5000 w. Ry Wld—May, 1897. Serial. 1st part. No. 12940 A.

The "Walker System" of Electric Traction. Justus Eck. Read before the Tramways Institute. Pointing out the various specialties and advantages of this system. Ill. 3500 w. Elec Rev, Lond—April 23, 1897. No. 12596 A.

ELECTROLYSIS.

Electrolysis from Electric Railway Service. Arthur J. Rowland. A study of the return circuit with a view to overcoming electrolytic troubles, or to so planning a road that they will never begin. 3800 w. Am Elect'n—May, 1897. No. 12867.

EQUILIBRIUM System.

The Equilibrium System of Feeding Electric Railways. Charles Ernest Paolo Diana Spagnoletti. Describes a method of working long lines of railways by electricity. Read before the Civil Engineers' Conference. 800 w. Elec Eng, Lond—May 28, 1897. No. 13294 A.

FARE.

The Indianapolis 3-Cent Fare Law. President Mason's report reviewing the situation is given in full. 3500 w. St Ry Rev—May 15, 1897. No. 12953 C.

FRONTIER Railway.

The Lewiston and Youngstown Frontier Railway. Brief illustrated description of railway in Niagara Co., N. Y. 900 w. St Ry Rev—May 15, 1897. No. 12954 C.

INTERRUPTIONS.

How Can Interruptions in New Power Installations be Prevented? (Wodurch Können Betriebsunfälle bei Strassen bahnen Möglichst Vermie den werden?) Discussing the interruptions and breakdowns which usually accompany the early working of electric trolley lines, with means for their avoidance. 2000 w. Deutsche Zeitschr f Elektrotechnik—April, 1897. No. 13584 B.

LEGISLATION.

Steam and Trolley in the Connecticut Legislature. Clarence Deming. A review of the legislative campaign, with summary of results. 2000 w. RR Gaz—June 25, 1897. No. 13698.

Street Railroad Legislation in Indiana. Statement of the situation regarding state legislation affecting railroad rates. The three-cent fare. 1400 w. Bradstreet's—June 19, 1897. No. 13602.

MOTORS.

See same title under Mechanical Engineering, Engines and Motors.

MUNICIPAL Ownership.

Municipal Ownership of Street Railroads in England. W. M. Acworth. Gives experience in England, stating the general tramway conditions, proportion of public ownership, power of purchase, public working, etc. 3000 w. R R Gaz—June 4, 1897. No. 13312.

PARIS.

The Proposed Paris Electric Tramway System. (Die Stadtbahn von Paris mit Elektrischen Betriebe). A detailed account of the official plan for providing Paris with a complete system of electrical transportation. 2 plates. 4000 w. Oesterr Monatschr f d Oeffent Baudienst—June, 1897. No. 13528 D.

POWER Plants.

How Shall we Arrange Electric Trolley Plants with View to Further Extension? (Wie Sollen wir Unsere Elektricitätswerke Bauen?) A comprehensive discussion of the arrangement of street railway power plants, taking into account the extension to additional lines. Two articles. 10000 w. Deutsche Zeitschr f Elektrotechnik—April, May, 1897. No. 13585 E.

STREET PAVING.

Street Paving an Improper Basis of Compen-

sation for Street Railway Franchises. Editorial discussing the objections to street paving as a compensation for street railway franchises. 2500 w. Eng News—June 17, 1897. No. 13487.

THIRD-RAIL.

Insulation and Bonding of the Third Rail Electric Conductor. H. K. Landis. Describes the construction of the new electric branch of the N. Y., N. H. & H. R. R. Ill. 1600 w. Elec Eng—June 9, 1897. No. 13337.

The Third Rail System on the New Haven Railroad. Illustrated description, with editorial. 2800 w. Sci Am—June 12, 1897. No. 13348.

TRAMWAYS.

Statistics of the Electric Tramways in Europe. (Statistik der Elektrischen Bahnen in Europa.) Giving comparative figures by countries for 1896 and 1897. The mileage has increased from 560 in 1896 to 905 in 1887, and in other respects in the same proportion. 2000 w. Die Elektrizität—May 22, 1897. No. 13567 B.

UNDERGROUND Railway.

Electricity on the London Central Underground. Describes the system of electrical equipment which is entirely American. Map. 1800 w. Elec Eng—June 30, 1897. No. 13813.

VIADUCT.

An Electric Street Car Viaduct. Illustrated description of the viaduct that carries the Consolidated Traction Co.'s electric car line on the turnpike between Jersey City and Newark over the D. L & W. R. R. Co.'s tracks. 1200 w. Eng Rec—June 5, 1897. No. 13273.

WAGONS.

Electric Repair Wagons. (Montage und Revisions Wagen für Elektrische Strassenbahnen.) Giving illustrations both of the American and German styles of wagons for making repairs to overhead trolley lines. 1000 w. Deutsche Zeitschr f Elektrotechnik—May, 1897. No. 13587 B.

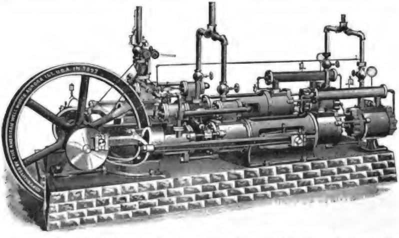
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

High Duty Compound Steam Driven Two-Stage Air Compressor.

THIS picture is made from a photograph of a high duty compound steam driven two stage air compressor for compressing air to raise and aerate water from deep wells for city water supplies, etc., economically. Its advantages are that (*a*) it economizes in the use of steam by using balanced steam supply valves; (*b*) high pressure steam is used in all of the cylinders for starting; then the steam is shut off from the large cylinders, and used expansively in the compound cylinder for continual operation; (*c*) high pressure steam is used around the compound steam cylinder to maintain a uniform heat and to save the loss of power caused by condensation (as used in marine engines); (*d*) it is arranged for adding the condenser for further economizing in operating expenses where fuel is expensive; (*e*) it economizes in the compression of air by first compressing it to a part of the pressure required, then taking out the accumulated heat by cooling thoroughly before compressing it to a higher stage; recompressing and cooling may be continued from stage to stage until the desired pressure is reached; (*f*) the largeness of its inlet valves saves the loss generally experienced from expansion of air by heat of frictional contact in passing through a small opening; (*g*) the outlet valves have the least possible loss in opening and closing on account of the largeness of the valve openings, their quick action, and small clearance; (*h*) air can be taken from the coolest and cleanest place, and conducted in a pipe to the compressor.



It is claimed that this method of raising water saves from fifteen to fifty per cent. over the best deep well pumping engines in use, compressing air from twenty five to seventy-five per cent. cheaper than can be done in the one stage compressor.

This engine should not be classed with the ordinary compressors used in mining and for operating quarry drills where high duty is not essential, but should be ranked with high duty pumping machinery, as the engine is finished and fitted for a well appointed engine room; the balance wheels are turned true and balanced, and the material and workmanship is of the best.

By the Chapman air-water lifting process, air is forced down the central pipe to a sufficient depth in the water, then up through the ejector on the lower end of the central pipe, lifting the water by

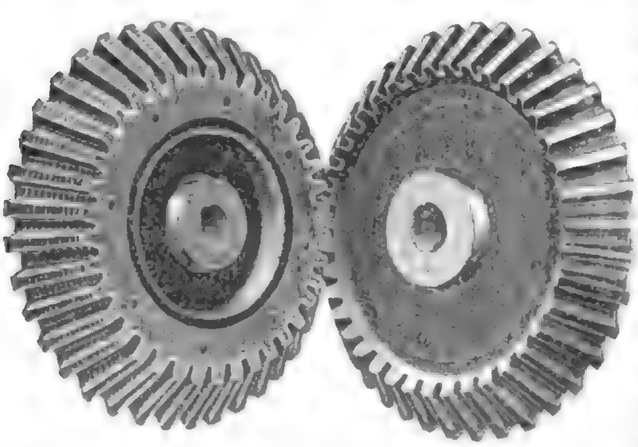
its force. The air expands as it nears the top, and is finally forced out with great velocity. It is claimed that it will lift from the same sized well, two to five times more water than can be gotten by any deep well pump, with a loss for friction of the air lifting the water guaranteed in no case to exceed more than fifteen per cent., and with much less expense for fuel and labor. Others use the expansion of air only ; the Chapman process uses first, the force, then the expansion, thereby enabling water to be lifted to greater heights.

When it is required to bring water a long distance from a river, etc., the duplex in-take is placed on the bank of the river, either above or below water, and pipe connections are made between the compressor and the in-take. The latter is not only duplex, but automatic. It is filled by suction, and the water is discharged by force to any distance or elevation.

This pump is manufactured by the American Well Works, Aurora, Ill., Chicago, Ill., or Dallas, Tex.

New Process Raw Hide Gears.

THE accompanying engraving illustrates a pair of gears recently made by the New Process Raw Hide Company, 248 West Railroad Street, Syracuse, N. Y., U. S. A., for the United States government. One of this pair of gears is of cast iron, the other of raw hide prepared by a process peculiar to the company above named. Under this process the raw hide is made hard and dense, somewhat resembling horn in external appearance,



and nearly, or quite, as strong and durable as cast iron. A peculiarity of this material which gives it great value in the industrial arts is its insonorous quality. When struck by, or struck against, another hard body, scarcely any sound is produced. This property, together with its hardness and durability, has given the material a large and increasing use in high speed gearing, which, if made wholly of metal, is apt to make a very annoying and unwelcome kind of music. In the use of electric motors of small size, running at high speed, it is necessary at times, when positive motion is required, to speed down with spur or bevel gearing. In such cases, if one in each pair of wheels be made of "New Process" raw hide, the train of gearing may be made to run almost inaudibly. In any case of a noisy gear and pinion, the substitution of a raw hide pinion will render the operation practically noiseless. The "New Process" raw hide is also used for other purposes, such as bushings, washers, reinforcing or binding mallets, chisel handles, etc. The pair of wheels illustrated are 18.143 inches in diameter, 3-inch face, 1½ inch pitch, and have 38 teeth. Pinions of very small size, say from ¼-inch to 1¼-inch pitch line diameter, may be made, and they work very nicely. We have seen very high-speed electric motors thus speeded down with good results.

An Important Contract.

THE St. Lawrence Construction Company, of New York, has recently awarded to the Westinghouse Electric and Manufacturing Company a contract for fifteen 5000-h. p. generators, to be erected at their plant at Massena, northern New York. This is the largest single order ever given for electrical apparatus, and the amount directly involved is about three-quarters of a million dollars. This contract, together with that recently given by the Cataract Construction Co. of New York, for five 5000-h. p. generators, for installation at Niagara Falls, N. Y., makes a total of twenty 5000-h. p. generators, having a total capacity of 100,000 h. p., which have been ordered from the Westinghouse Electric & Mfg. Co., this year. The five generators for Niagara Falls are well under construction, and the other fifteen, required by the St. Lawrence Co., will be immediately proceeded with. Their construction will give employment to a large number of men. The placing of these important contracts has undoubtedly resulted from the great success of the three 5000-h. p. generators already installed at Niagara Falls by the Westinghouse Electric & Mfg. Co.

The Strange Forged Twist Drill.

THESE drills are made by forging. The twist and groove are simultaneously hammered into them at a proper red heat, and it is claimed that they will do one-third more work than the old style twist drills. It is asserted that these drills will hold their edge as persistently as any forged lathe or planer tool, and that they possess the maxi-

mum strength of the material. A demonstration, free of charge, is offered to anyone who will, by mail or otherwise, request it of the manufacturers, the Strange Forged Twist Drill Company, New Bedford, Mass.

THE STRANGE FORGED TWIST DRILL.

Stamped and Embossed Sheet Metal Double Ender Rowboats.

THE engraving illustrates one of a line of boats made by an entirely unique process. They are formed by stamping metal plates in large and expensive dies, immense and very accurate drop presses being used for this purpose. These plates, of which there are only 8 to the largest boat, are then riveted and doubled-seamed together, making the strongest, lightest and most durable boat ever devised; one that will not crack open or become leaky when exposed to the weather, or water-logged and heavy when in use. This method of manufacture is the invention of Mr. W. H. Mullins, a manufacturer of architectural sheet metal work and statuary at Salem, Ohio, U. S. A. At present he has ready for the market two styles of these metal boats, the one which he calls the "Double Ender" row-boat, 15 feet long 42 inches beam, 25½ inches at ends and 14 inches amidship, shown in the cut, and the "Get There" safety ducking boat, 36 inches wide, 11 inches high to top of deck, 14 inches high to top combing. The materials used are galvanized steel, manganese bronze, and aluminum. Many testimonials to the merits claimed for these boats have been received by Mr. Mullins.

STAMPED AND EMBOSSED DOUBLE ENDER SHEET METAL PLEASURE BOAT.

Transmission of Power Eighty Miles.

A CONTRACT for the transmission of power of the river running through the Santa Ana Cañon to Los Angeles and Pasadena, has been concluded between the Southern California Power Co. and the General Electric Co. The amount of power to be transmitted at first is four thousand horse-power. The station will be located in the Santa Ana Cañon, twelve miles from Redlands and about eighty miles from the towns in which the electric power will be utilized. The water will

be taken from the river through canal, flume, and tunnel along the side of the cañon. Here it will be led into a pipe line 2,200 feet long, giving what will be equivalent to a vertical fall in the water of 750 feet. The wheels will be of the impact type, directly connected to the generators. There will be four of these wheels, each of 750-kilowatt (1,000 h. p.) capacity. The maximum line potential will be 33,000 volts, to which potential the initial voltage will be raised by twelve 250-K. W. step up transformers. This transmission will be the longest commercial electrical power transmission yet undertaken, as well as that using the highest voltage. At present the longest is that transmitting the power of the waters of the Ogden Cañon in Utah to Salt Lake City, a distance of 36 miles. The Los Angeles transmission will be more than twice that distance, and three times the longest distance yet tried with the power of Niagara, which to date has been transmitted only to Buffalo, a distance of twenty-six miles.

Fire-Proofing.

THE New York & Staten Island Electric Company are erecting at Livingston, Staten Island, a new power house of modern construction. The walls of the building are brick, and the roofs have steel trusses covered with corrugated iron. The roofs are arranged with suitable monitors, with skylights for light and ventilation. On the building is a large wire tower of steel construction. The engine room is arranged for a travelling crane of thirteen tons, capacity. The building has been constructed with the idea of having it absolutely fireproof, and arranged in an up-to-date manner. The roof of the engine and dynamo portions of the building is lined underneath the corrugated iron with the Berlin Iron Bridge Company's "Anti-Condensation" fire-proof roof lining. The Berlin Company, East Berlin, Conn., have the contract also for furnishing and erecting all the steel framework and the covering for the plant.

THE Detroit Graphite Mfg. Co., of Detroit, Mich., has recently acquired the title to the graphite mines in Northern Michigan from which they have been making their Superior Graphite Paint. The ore from this mine produces the best pigment for paint so far found. This pigment is reduced to a fineness never before obtained from graphite, and none of the graphitic carbon is taken from it to be used for other purposes. It is unassailable by acids, or chemicals of any kind, and is of an absolutely uniform quality. The Superior Graphite Paint made by this Company has obtained an enviable popularity.

NEW CATALOGUES.

Cahall Sales Department, Pittsburgh, Pa., U. S. A.=Illustrated pamphlet entitled "Big Boilers," in which the merits of the Cahall system of boilers, where headroom enough is available, and of the Babcox & Wilcox type (as manufactured by The Aultman and Taylor Machinery Co.), where there is too little headroom for vertical tubes, are set forth in a forcible and convincing manner, and in which facilities for manufacturing in the most approved style of the art, and in almost unlimited quantity, are stated.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A. (Burnham, Williams and Co.)=Circular illustrating and describing the exhibit of the Baldwin Locomotive Works at the Tennessee Centennial and International Exposition.

Pneumatic Engineering Company (Incorporated), New York=A beautiful pamphlet (half-tone illustrations). A manual setting forth the features of the business of this company, which consists in the supply of machinery for air-lift pumping.

Variety Machine Company, Warsaw, N. Y., U. S. A.=Catalogue of the "Rochester" hay-carriers and slings.

Builders' Iron Foundry, Providence, R. I., U. S. A.=(*a*) Part II of essay entitled "Our Share in Coast Defence," giving extracts from government specifications and reports relating to the 12 inch breech-loading rifled mortars made at these works, (*b*) Part III of same essay, giving a full illustrated account of the spring return mortar carriages used for mounting the above named 12-inch rifled mortars.

W. S. Rockwell & Co., New York.=Pamphlet describing features of their business as furnace engineers, designing and erecting furnaces, for oil, gas, coal, or wood fuel, adapted to different manufacturing purposes.

Fred H. Nichols, Lynn, Mass., U. S. A.=Leaflet illustrating and describing Nichols "Perfect" safety gate for grade crossings.

New York University, New York.=(*a*) Announcements for the "University College" for 1897–98. (*b*) Annual circular of the New York University School of Engineering.

Purdue University, La Fayette, Ind., U. S. A.=Annual catalogue for 1896-97, with announcements for 1897–98.

Lamson Consolidated Store Service Company, Lowell, Mass., U. S. A.=Pamphlet containing illustrated description of pneumatic tube apparatus for transmitting packages and cash to and from sales counters and cash-rooms.

The Hayden & Derby Manufacturing Company, New York.=Illustrated catalogue and price list of "Metropolitan" injectors and "H-D" injectors.

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LESSONS OF THE GREAT ENGINEERING STRIKE IN ENGLAND.

By J. Stephen Jeans.

THE struggle that is now going on in Great Britain for the establishment of an eight hour day in the engineering industries of that country has a more than merely local interest. It points a valuable moral, and inculcates a number of useful lessons, to those engaged in the same and kindred industries in other countries, and not least so in the United States. I have thought, therefore, that an account of the movement for an eight-hour day, and what it involves, from the point of view of both parties to the controversy, may be of special value to the great engineering industries of America, where the eight-hour day has already, in some cases, passed from the merely academic platform to the region of actual practice, and where the British experience of to-day may easily be reflected to-morrow.

Although the eight-hour-day movement has an interesting historical side, I do not purpose to touch upon it, beyond stating that this limit of work has been a desideratum and aim of certain unions for many years. One of the oldest shibboleths of modern labor is expressed in the doggerel lines:

> Eight hours' work and eight hours' play,
> Eight hours' sleep and eight bob a day;

but the cases in which this goal of the worker has been reached have been very few. In Great Britain, the demand has been formulated with unusual force and persistency on behalf of two leading industries widely apart in their conditions and characteristics. The miners, or at least a majority of them,—for the movement has not their universal endorsement,—have agitated for years past for an eight-hour day from bank to bank, which would, in a large number of cases, mean

six hours of actual work; while in the engineering industries, which secured a reduction of the hours of labor from ten to nine as far back as 1870, a considerable pressure has been brought to bear on employers during recent years to concede a further reduction from nine to eight hours, without any corresponding reduction in wages. The nine-hour day was won at "the point of the bayonet," having been preceded by a long and disastrous strike. Until now, however, there has been no actual strife between employers and employed with a view to the establishment of an eight-hour day, although the matter has been more or less agitated ever since the nine-hour movement was inaugurated more than a quarter of a century ago.

The workmen, in making the present demand, claim that a reduction in the hours of labor is required, in order to give the workmen more time for study and recreation; that the proposed system would enable the workman to start work in the morning with his breakfast, and consequently in a fitter condition for actual labor; and that the effect of reducing the hours would be to provide more employment, and consequently to reduce the number of artisans out of work. Another claim has been made, strangely inconsistent with the one last-named,—namely, that, under the improved social conditions assumed, the average workman can do as much work in eight hours as in nine, chiefly because he will be more fit, but also because there will be less lost time in getting to work, and only one break in the day, instead of two.

On the other hand, the employers refuse to admit that the claims of the workmen are reasonable, or their reasoning accurate. They argue that the reduction in the hours of labor would mean an increase of five to ten per cent. in the cost of production, which would be disastrous in face of the severe foreign competition now prevailing; that already they have the utmost difficulty in securing orders against continental countries and the United States; that, as all machinery in well-regulated shops is already worked to its utmost capacity, it would be impossible to make up for lost time; that, apart from this controlling aspect of machinery, their experience of the nine-hour-day change did not show that workmen were ready or competent, as a general thing, to do as much work in a shorter as in a longer period; that establishment charges could not be reduced in proportion to the reduction in hours; that the change would increase, *pro rata*, the maintenance of machinery; and that, if the eight-hour day is to be adopted, it should be accompanied either by a reduced rate of wages, or by the removal of the restrictions at present imposed by the workmen's unions, in reference to piece-work, apprentices, over-time, the working of machine-tools, and other matters.

The attitude which the employers have taken has been to a large extent affected, if it has not been actually determined, by the ascertained facts as to the conditions prevailing in competitive countries. Already the hours of labor in Great Britain—at any rate in the engineering industries—are less than those in any competing country, and are materially less than in Germany, which is England's chief competitor. Till now, however, British manufacturing engineers do not appear to have been much hurt. It is true that they have had experience from time to time of serious and prolonged depression; but the last two years have been the most active and satisfactory that they have ever had. The value of the British exports of mining, agricultural, textile, and other machinery has increased considerably, and most of this business has, of course, to be carried on in the face of the keenest competition. Home industries provide, moreover, for a very large volume of work that is little, or not at all, affected by foreign competition, such as that done for the navy,—on which about eight millions sterling is being expended this year,—and the building of engines and other equipment for the enormous ship-building trade.

The present strike, however, is not merely a function of the demand for an eight-hour day. In a larger and wider sense, it is a practical protest of capital against the repeated and persistent attempts of the workmen to control the business of their employers.

The present dispute affects about ten leading trade unions in the country. Some of these are among the strongest unions in Europe. Foremost in this category stands the Amalgamated Society of Engineers, which was founded about half a century ago, and has at present a membership of nearly a hundred thousand. The other unions include the Steam Engine Makers' Society, the Amalgamated Society of Tool-makers, and the United Machine Workers' Association.

It is not, however, to be supposed that all the skilled artisans in the country connected with the engineering trades are members of these and kindred societies. The number of such workmen is not accurately known, but it is believed to be near half a million; the trade unions have not more than one-fourth of this number in membership.

The employers in the engineering industries of Great Britain have long felt that they were greatly handicapped in their competition with foreign countries, and more especially with the United States, by reason of the tyranny of the trade unions. In no other country is the system so powerful, so dictatorial, so exacting in its demands, so unscrupulous in its methods. The employer who stands the slightest chance of making reasonable progress in his business must always reckon with the trade-union programme, and must be ready to make concessions when the councils of these organizations require them.

Usually all questions of dispute are settled by makeshift compromise. It might be supposed that the State would, to some extent, come to the aid of the employers on the ground that the action of the unions was generally calculated to be in restraint of trade. This, however, is hardly an attitude which any government of late years has cared to take up. The individual member of parliament dare not take up an antagonistic attitude, or he would incur a serious risk of losing his constituency at the next election. The catching of votes is the chief end of the modern legislator. To "go one better" is the chief end of the government that would remain in power, or snatch that most coveted of all possessions from its rival. No government could hope to succeed that was pronounced against labor movements. In a large number of cases both the government of the day and the individual legislator are afraid to act, lest the hostility of the electorate should be roused. Sitting astride the fence has, therefore, become a favorite attitude on the part of both. Responsibility is declined wherever it is likely to make against the voters. Back-bone on labor questions is almost an unknown quality of British legislation, unless it should be exercised in laying some new burden on the employer. Each party competes with the other in the endeavor to prove that "Codlin's the friend; not Short." Rarely does a British statesman venture to say all that he desires to express. The stock-in-trade of the average politician, and especially of the so-called responsible minister, is usually vague generalities, which tickle the ears of the groundlings, but mean nothing in actual practice.

All this flabbiness induces the labor leaders to put on a bold front. They have long learned that, if they are to have their demands complied with, "they themselves must strike the blow." They know that they will not suffer much opposition from the government. They know that they can count on a large amount of outside sympathy and support from irresponsible philanthropists. The labor leader of to-day is a tactician, a disciplinarian, a wrestler, a soldier, a policeman, and a lawyer, all in one. He knows exactly how far he can go without being caught in the meshes of law, and the statute-book enables him to go a long way. He has many weapons at his command. Bluff, cajolery, persuasion, sympathy, fear, and force are each used in turn, according to the requirements of the case.

The chief complaint of the employers against trade unionism is, not that it attempts to secure higher rates of wages for the workman, or even shorter hours of labor, but that it is with their demands as with the Hollanders of the days of Hudibras:

> In matters of commerce the fault of the Dutch
> Is giving too little and asking too much.

The employers would give a great deal to get rid of the trade-unionist tyranny in reference to piece-work, the apprentice system, and the conditions under which machine tools shall be worked. But at the same time that the trade unions insist on shorter hours or higher wages, they demand that piece-work shall, as far as possible, be got rid of; that the number of apprentices relatively to journeymen shall be strictly and most unreasonably limited, and that the individual workman shall be permitted to do perhaps not more than one-half of what he easily might do.

The rank and file of the employers in the engineering trades of Great Britain refuse to believe that as much work can be produced by the average workers in eight hours as in nine, or, as it is generally and more specifically put, in the proposed week of forty-eight hours as in the existing week of fifty-three hours. Such a reduction is equivalent to 9.4 per cent. in time, or to an increase of 10.4 per cent. in wages, taking the average wages of the skilled artisan at 33*s.* 4*d.* per week, which is the rate accepted by the trade-union officials. Assuming the wages paid in the engineering industries to be about one third of the total cost of production, the eight-hour day would involve, in wages alone, an increased cost of 3.47 per cent. It has, moreover, been computed that, on the basis of fifty-three hours, a man's time, in itself, is equivalent to the working charges of the concern, which would give a further increase of 3.47 per cent., or a total extra cost of 6.94 per cent., not including the inevitable increase of fixed charges due to the shorter day. On the other hand, employers in the engineering industries generally do admit that men working at their best on piece-work turn out much more work—say, from 25 to 30 per cent.—than men working on time usually do. But the workmen's union will not allow the men to work piece-work where the system is not already established. Their rules provide that a member of the society who takes piece-work where it is not already declared to be established shall be fined 20*s.* for a first offence and 40*s.* for a second offence, and shall be expelled for a third. Wherever the Amalgamated Society is strong enough to carry its own way, piece-work is disallowed and forbidden. Cases occur where members of their own societies in certain branches are allowed to work on piece, while those in other branches are not. Such a condition of things has led a well-known British ship-builder to caustically criticise "the incongruity in legislation which forbids the workman to contract with his free will, with his employer, for pecuniary aid in case of disablement by accident, and at the same time permits him to be compelled, *against his will*, to contract with a trade union for the arrangement of the terms of his employment."* The rules of the Amalga-

* Paper read by John Inglis before the Philosophical Society of Glasgow, March 27, 1894.

mated Society are tyrannical not only as against employers, but as against their own members, whom they coerce into practices and regulations of which a large proportion do not in their hearts approve. That, however, is another matter, and by the way. We are now concerned only with the question of how far the attitude taken by the unions affects the status of the employers and the cost of production.

There appears to be sufficient evidence of the fact that, the hours of labor being reduced in cases where the piece-work system is in force, the cost of production has not been materially affected. Some years ago the hours of women's labor in Germany were fixed by law at eleven as a maximum, with one hour's rest during the day, and an extra half-hour for workers who have households, when required. In nearly every case where piece-work is the rule, it was proved that the production had increased with the reduction in the hours of labor.* In some cases, when the hours were reduced, the speed of the machinery was increased, but the speeding of the machinery can be increased only in limited measure, and in well-organized factories the machinery is already being worked for all it is worth; otherwise there must be an avoidable leakage, which should not exist.

It is not necessary that we should here discuss the comparative merits and economies of piece-work and day wages. Every employer is cognizant of the greater facilities which piece-work, properly organized and directed, offers for economical production. No doubt the use of piece-work calls for greater supervision than the fixed-wage system. It has been found in engineering workshops, where repairs are carried on, that with piece-work there is a great tendency on the part of workmen to renew more parts than are actually necessary, and there is also a danger of material being wasted by unscrupulous workmen, especially if parts can be removed more quickly and easily by destroying them.† Nevertheless the general effect of the system is to benefit both employers and employed by increasing wages and reducing the cost of output.

The British trade unions describe piece-work, in the language of the rules of the Amalgamated Society of Engineers, as "one of the greatest evils" of our industrial system. The unions hold, or encourage the assumption, that under such a system the employer profits at the expense of the workman; that it often involves loss to the men, who do not always earn full wages and have to make up the deficiency; and that it has a tendency to reduce actual earnings to the lowest possible amount. The system is, moreover, described as an encouragement to "sweating," which is declared to be prejudicial to the workmen.

* Reports of German factory inspectors.

† Paper read on "Piece-Work in Car Shops," before the Western (U. S.) Railway Club.

From these ideas and prejudices against the piece-work system not a few strikes have taken place in England. One of the most notable occurred a few years ago at the works of Easton & Anderson, on the Thames. Returns were collected from the leading engineering firms throughout the country at the instance of one of the most influential associations of employers, which showed that the wages paid to individual workmen, engaged on piece-work, on an average of all the chief districts, was about 40 per cent. more than the weekly time-rating, and that weekly ratings were higher in districts where piece work is usual than where it is never resorted to. It was proved, also, that the percentage addition of piece-work balances was higher in those shops where the weekly ratings of the men were on the highest scale, showing that the best men are attracted to districts where piece-work is general. I may here add that the late Mr. Mundella, at one time president of the Board of Trade in Great Britain, computed that, of the two hundred and forty millions' annual value of British exports, fully 90 per cent. were made by piece-work,—a computation, which, if accurate, demonstrates the futility and unreasonableness of the hostility of some trade unions in trying to eliminate it.

It is only fair to add that piece-work, both in England and elsewhere, has been liable to abuse, and may have had to answer for abuses. As a case in point, the experience of the ship-building industry may be mentioned. When this industry was specially active some years ago, it was stated that in many instances the platers, whose time wages were 6*s*. per day, were earning at piece-work within a shilling of £2 per day, while their helpers, whose rating was 4*s*. per day, were earning at the same piece-work, only an additional shilling, or 5*s*. in all. It is natural that objections should be raised to this extreme disproportion in the distribution of piece-work benefits, and especially in an industry like ship-building, where stoppages are frequent. Reasonable employers fully recognize the importance of paying piece-workers with some regard to their ordinary time ratings.

There are various other pending issues which have often led to strikes in Great Britain. The workmen have again and again called for conditions that virtually mean the suppression of over-time, demanding that each day's work should stand upon its own merits, and that over-time rates should commence each day as soon as the ordinary day's work is brought to a close, whether or not time has been lost during the day. This position was abandoned, and latterly the rule has been that fifty-four hours per week must be worked before over-time rates begin to tell, time and a quarter being paid for the first four hours of over-time of each day, and time and a half for additional hours thereafter, provided these fifty-four hours have been

worked and paid for at ordinary rates. But the workmen's unions would abolish over-time altogether, if they could, despite the fact that their own members flock from shops where no over-time is going on to those where it prevails, and despite the fact that, as the engineering trade is especially subject to periods of long depression and of great activity, often of short duration, they could not practically be debarred from taking advantage of brisk trade when offered.

There are still other directions in which trade unionists, in making a demand for shorter hours of work,—a demand with which, *prima facie*, most of us would sympathize, and which many of us would heartily support,—have made it extremely difficult for the employers to meet them, and have practically compelled an attitude of serious resistance. One of these is the limitation of the number of apprentices. Another is the limitation in the number of machines which a workman can attend to,—the union forbidding a man to work more than one machine, and in many cases more than one tool on each machine; while frequent attempts have been made to establish a minimum rate of wages, oblivious of the fact that, if it were sought to pay to a less efficient or less highly-skilled workman wages in excess of his fair remuneration, as measured by the value of his work, this could be effected only at the expense of his more efficient and more highly-skilled compeer. The spirit and practice of British trade unionism, in short, is the discouragement of individual effort or exceptional skill.

The employers are naturally rankling under a sense of the unreasonableness of the workmen in demanding shorter hours and daily wages at the same time under the conditions stated. If piece-work were generally adopted, the result would be different. In that case it is not probable that the demand for an eight-hour day would be so zealously prosecuted. But the employers object that the workmen want to have their cake and eat it too—to score at both ends, and that, too, in such a way as effectually to prevent the employers from recouping themselves from the loss that appears to be inevitable under the proposed new system, as now formulated.

The most curious phase presented by this question is the comparatively limited numerical strength of British trade unionism relatively to its vast influence as a social and economic force. Some years ago Mr. Frederick Harrison pointed out that, of the twelve millions of those who earned wages in Great Britain, less than one million were in union, so that "at the utmost trade unions affect substantially only the minority,"* while "the unionists are a mere fraction—the aristocracy of labor," which "is not now relatively growing." In

* Report of Industrial Remuneration Conference in London.

spite of exertions to create a sympathy for unionism, the system "in its average, and certainly in its lower types, tends rather to sectional and class interest; it divides trade from trade, members from non-members; and especially it accentuates that sinister gulf that separates the skilled and well-paid artisan from the vast destitute residuum."

After this review of the tyrannous attitude and vagaries of British trade unionism, American manufacturers may well feel that they have much to be thankful for. In American practice, as I am informed, there are no such restrictions on piece-work as in England, but each workman, acting on his own initiative, as a rule, makes his own individual arrangements. So far from any attempt being made to limit the number of machines or tools that a mechanic can tend, as in England, the American mechanic takes as many as he can, knowing that, the more he does, the better will be his remuneration. It is, consequently, not an unusual thing to find an American mechanic tending two, three, four, or even half a dozen tools, while his English congener is *forced by his own organization* to be satisfied with one. A uniform rate of wages, again, which is a desideratum with a number of British trade unions, would be scoffed at by the American, who insists on earning as much as he can, and practically applies in every-day life the sound and healthy principle that the race shall be to the swift and the battle to the strong. Surely, if all this teaches anything, it teaches the lesson of maintaining that individual liberty which the British workman has voluntarily sacrificed for a mess of pottage. From the point of view of international competition, at any rate, there can be no possible doubt of the demerits and disadvantages of the British system, which is practically a premium on the freer ideas and habits of the American citizen.

Recent conferences and inquiries have pretty well established the fact that English workmen, as a rule, are better paid, better fed, and work under more healthy, normal, and favorable conditions, than the workmen of any other country, and, in saying this much, I am not disposed to except even the industrial workers of the United States. It may be true—it probably is—that the American skilled workman not only has higher wages, but can make his money go further in respect of purchasing power. But no one who has compared the economic conditions of the two countries can fail to have observed that in the United States the average workman works for longer hours and under much higher pressure, so that he really gives more return for his wages than his congener in Great Britain.

It is not too much to say that no other country has suffered so much as England from conflicts between capital and labor. The annual loss to British industries from this source varies greatly from

year to year, but in the aggregate it must be enormous. The strikes of coal miners alone during the last five years are estimated to have entailed a total loss of ten to twelve millions sterling.

Attempts have been made by the establishment of courts of arbitration, by systems of conciliation, by coöperative movements, and by other industrial arrangements, to reduce the number and intensity of such disputes, but, if these expedients were generally of value, and especially if they were to be depended on, we should not now witness the strife that is pending in one of the most advanced and intelligent industries in the country.

Manifestly, the question that comes uppermost, in view of so serious a dislocation of industry as that which I have described, is that of how the parties and countries concerned can avoid such troubles in the time to come. This is a problem that stands as much in need of solution in the United States as in any European countries, and the attempts at solution furnished by American experience have not been unimportant. It is impossible in an article that has already reached such limits to discuss these, but the piece-work systems introduced at the Midvale Steel and Baldwin Locomotive Works, and at the works of William Sellers (incorporated), described in a previous issue of this magazine, may be referred to as entitled to special notice, if not to general imitation.

The most important and pressing problem presented for solution, so far as the United States are concerned, is that of whether the British situation or the American situation in relation to trade unionism is to be the industrial situation of the future. Neither country can stand still in view of the changing conditions presented by the great social upheaval that is going on all around. Labor is unquestionably more highly organized in Great Britain than in any other country. Is this not the inevitable result of Great Britain's priority of place as a manufacturing country? And, if it is due to that factor, is it not probable that in newer countries labor will acquire the same power and use it as remorselessly as it is now being used in leading British industries? If so, is it not probable that we are approaching a period when the troubles that have been faced and fought in Britain will engross the thoughts and efforts of American manufacturers? In other words, is the struggle between capital and labor being fought out in Britain once for all, or will it have to be gone over again, *mutatis mutandis*, in other industrial countries? Is the present British attitude of capital and labor the last word in this controversy, or may we look in the near future for conditions more nearly assimilated to those that prevail in the United States?

THE STRENGTH AND FAILURE OF MASONRY ARCHES.

By Henry Harrison Suplee.

THE arch is probably one of the oldest forms of masonry construction for spanning openings, examples having been found in China, in Egypt, in ancient Greece, and in Italy, while in medieval and modern times arches have played a most important part in the construction both of bridges and of buildings.

While we have no recorded evidence of the theoretical knowledge possessed by the ancient constructors, it is certain that until comparatively recent times the action of the forces in arches, and the manner in which the materials resist those forces, have been but imperfectly understood, nearly all the most important structures of this form having been built according to empirical rules, deduced from hard experience and the observation of preceding successes or failures.

From the time of Newton the theory of the arch has been discussed by innumerable writers, among whom, as the most noted, may be included Gregory, de la Hire, Coulomb, Eytelwein, Navier, Lamé, Poncelet, Moseley, and Rankine. All of these, with the exception of Navier and Lamé, seem to have accepted the so-called statical theory, stated in its clearest form by Coulomb in 1773, and treated with the greatest mathematical elegance by Moseley in England and Scheffler in Germany.

Since the introduction of railways, however, the importance of taking into proper consideration the heavier moving loads has caused the statical theory to be regarded as not altogether equal to the conditions, and the increasing knowledge of the properties of materials under stress, together with the widening appreciation of the importance of considering the question of elasticity, has led engineers to believe that the elastic theory should also be applied to the arch, whether built of masonry or of metal.

The elastic theory, as applied to arches, is due to the researches of Bauschinger, Köpcke, and others, and appears to have been first clearly stated by Winkler in 1867, followed by Weyrauch, in 1879, and Müller-Breslau, in 1886, and has been most fully confirmed by the important experiments made by the Austrian Society of Architects and Engineers from 1891 to 1893, and published in 1895.

Before proceeding to give some account of these "Austrian Ex-

periments" and the valuable lessons drawn from them, it may be of interest to examine in a rather elementary fashion what an arch really is, and what we ought to expect of it under various conditions.

Probably the first arch consisted simply of two massive stones, leaning against each other in the form of an inverted "V"; with proper choice of angle and suitable placing of abutment stones to receive the horizontal thrust at the bases, such a construction makes a strong and effective means of spanning entrances and other openings in buildings. It is in this manner that the entrance to the great pyramid is arched, and the load over the King's Chamber is discharged in the same way. This primitive form of arch, possibly suggested by observation of rocks in nature, occurs in many places in Egyptian architecture, and doubtless led up to the use of two inclined stones with a horizontal one between them above, this forming a true arch in the modern sense of the term, while the two-stone construction may be considered the germ.

Crude piles of stones, forming actual arches of several stones, are found in the so-called cyclopean structures, of which an excellent example is found near Epidaurus, in Greece.

In all these cases the structure is maintained in position entirely by the force of gravity held in equilibrium by the resistance of the material; and, as it was soon found by experience that arches of different shapes could be made stable by varying the loads upon various parts, it is not surprising that such theorizing as was at first made upon the subject was based entirely upon statical considerations, and assumed the arch to be composed of rigid, incompressible blocks, held in position solely by the force of gravity opposed by the crushing strength of the material. When moderate spaces are spanned by arches so massive that the stationary weight is greatly in excess of any moving load which can come upon it, this theory is not so far from the actual conditions as to reveal its defects. So we see the early structures of the Romanesque and Norman periods maintaining their equilibrium by a brutal excess of strength quite in keeping with the massive walls and narrow openings, but altogether unsuitable for modern conditions. When in later times attempts were made to lighten the structure, the artistic intuitions of the Gothic cathedral builders developed forms nearly in statical equilibrium and marvellously graceful in appearance, but even these frequently failed when applied to bridges of moderate spans and dissimilar conditions.

Coming down to more modern times, we find numerous attempts to investigate the real conditions and action of the forces in arches, especially for large spans; and the theory of Coulomb, expanded and developed by later authors, showed that the forces could be considered

as concentrated along a curved line, and that, so long as that line maintained itself within certain limits of the arch ring, the structure would be stable, but that, when it departed from those limits, the arch would fall.

When the arch is symmetrical and subjected to a symmetrically-disposed load, this equilibrium curve, as it is called, can readily be determined, both inposition and shape, either by analytical or by graphical methods, and the thrust and pressures in the arch determined with a degree of accuracy quite within the limits of construction.

When, however, in addition to the symmetrical and stationary loads, there are loads varying in magnitude and position, the problem becomes much more complicated, and the immense mass of writings upon the subject shows that its importance is recognized by engineers, and also that all are by no means of the same opinion regarding the correct solution of the problem.

As an analogy for the consideration of the general reader, the arch may be compared to a catenary, or curve formed by a chain fastened at both ends at points in a horizontal line and allowed to droop in a curve. So long as the chain is supporting only its own weight, or a number of uniform weights suspended from it at equidistant points, the curve will be symmetrical and determinate; but, when an odd weight is attached anywhere, the curve will be distorted, and its investigation greatly complicated. The catenary, when inverted, becomes the equilibrium curve for a similar arch under the same loads, all the directions being reversed, and all the tensions converted into thrusts.

The best illustration of the actual condition of affairs is that given by Professor Fleeming Jenkin, reproduced below.* Professor Jenkin takes a model arch, of which the voussoirs, or separate stones, are made with curved faces, so that they may assume various positions in accordance with the varying conditions; and he shows it subjected to various loads. Thus, in Fig. 1 the load is placed in the center, and, as the arch stones are free to rotate, the crown of the arch is depressed. Now, a line drawn through the points of contact of the curved faces gives us the real arch existing under these conditions, and we see at once that the highest point of the curve is immediately under the weight, and that, if the weight were removed, the stones would rearrange themselves, and the curve flatten at the top. When two weights are placed as in Fig. 2, the haunches are depressed and

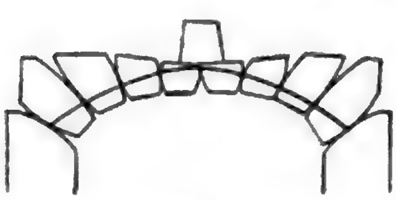


FIG. 1.

* Encyclopedia Britannica, Art., Bridges.

the crown rises, and the equilibrium curve takes the reverse movement, rising at two points directly under the weights. Likewise in Fig. 3, the weight placed on one side causes a distortion which changes the form of the equilibrium curve, the high point being again under the load. As one writer has neatly put it, "the curve humps itself up to meet the load."

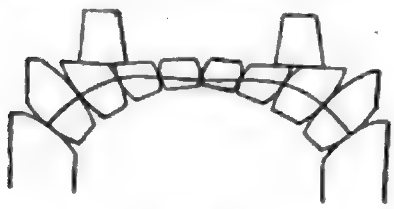


FIG. 2.

Now, to quote Professor Jenkin's words, "in the model each voussoir is free to roll, because the bed stones are curved. In an actual arch the bed joints are plane; nevertheless the stones do turn round to adapt themselves to the pressure, but the result of this rotation is to render the compression along the upper and lower halves of the stone unequal. One edge is more compressed than the other; the couple tending to turn the voussoir, and actually allowed to do so in the model, is met by an equal and opposite couple due to the unequal compression of the stone.

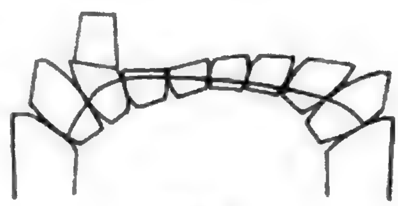


FIG. 3.

"This couple is the necessary result of a pressure which is not axial; an equilibrated polygon cutting the joints at various distances from the center is, therefore, as correct an indication of the actual forces present in an actual arch with flat joints as in the model with curved joints; but we must remember that, where the joints are flat, the pressure will be unequally distributed whenever the line of the equilibrated polygon does not cut the center of the joint. *Greater or less elastic resistance* in the stone corresponds to a greater or less curvature in the surface of the joint. A small distortion of the arch will restore equilibrium when the stone has a *high modulus of elasticity*.

"The ring with plane bed joints is in stable equilibrium, and adapts itself to new distributions of load for precisely the same reason as the model with curved joints, but in the one case the couple called into play to move the voussoir is actually cancelled by the new position which the points of contact assume; in the other case it is balanced by the equal and opposite couple resulting from the resistance to motion due to the hardness of the stone."

Under the old statical theory the stone was supposed to be rigid, and, when the equilibrium line approached too near the outer limit, "rotation" was assumed to take place, the joints on the opposite side of the voussoir opening and the entire structure suffering distortion. The only resistance which the stone was supposed to offer was based

on its ultimate crushing strength, and the question of its elasticity was not taken into account; indeed, its modulus of elasticity was rarely found.

It is evident, however, that, if we consider the material as possessing elasticity, the yielding of the voussoirs at the points under greatest pressure might cause a tendency to rotation, and consequent opening of joints, long before the crushing strength was approached, and that, when the load which caused this action was removed or shifted, the parts might resume their normal positions and relations without having suffered any permanent deformation, while, if the yielding to unequal pressure was sufficiently great, the portions under tension might be permanently injured by the action of loads much smaller than those which the old theory would consider serious.

The elastic theory having been considered and practically accepted for metallic structures, it became a question how far it was applicable to those of masonry. In order to solve this, as well as to add to the stock of experimental data upon the general subject of arches of various materials, the Austrian Society of Engineers and Architects appointed, several years ago, a committee composed of some of its most eminent specialists to investigate experimentally the behavior of large arches under known stresses, and to test the whole subject upon so large a scale as to furnish data of real practical value for future use in arch-design and construction. The report of this committee, published in the journal of the society and subsequently in a special reprint consisting of 131 folio pages and 27 large plates, is undoubtedly the most important publication on the subject of the arch which has ever been made. The technical details of the subject are too voluminous and mathematical to be given here, and for them the professional engineer must be referred to the original publication; but an account of the general nature of the tests and the results obtained are of so general interest and importance as to be worthy of general attention. The preliminary portion of the work consisted in experiments made upon small arches, such as are used in fire-proof building between floor beams and the like, and these need not be discussed here. The important tests were those made upon several large arches of different kinds.

Those in which we are interested were made upon four arches, each of 23 meters' (75.4 feet) span, 4.6 meters' (15.1 feet) rise, and 2 meters' (6.56 feet) width. Three of these arches were of materials in general use,—*i. e.*, rubble, brick, and concrete,—while the fourth was of the so-called Monier construction, consisting of concrete in which is embedded a network of round iron rods to assist in resisting the tension stresses.

The location of the experimental arches was well adapted for the purpose, being on the line of the Western Railway at the Purkersdorf station near Vienna, and the general arrangements will readily be understood from the photographs, of which Fig. 4 shows, on the left, the brick arch, and, on the right, the rubble-stone arch, the latter with a portion of the test load upon it. Fig. 5 shows the concrete arch ready for the application of a load, with the apparatus for measuring the deformation, while Fig. 6 shows the Monier arch under test, with a portion of the iron arch under construction in the foreground.

Although the curves upon which the arches were constructed were arcs of circles, yet for so flat arches the circular arc differs so little from the equilibrium curve for uniform loading that the latter occupied practically the middle of the arch ring. The test, therefore, was made by loading one-half of the arch gradually, measuring the deflections very carefully at points along the entire curve, and watching carefully for the appearance of cracks or other symptoms of distress. This one-sided loading was intended to cause the distortion of the arch to a much greater extent than was likely to occur in practice; if the cracks appeared at the points indicated by the theory, the deductions were to be considered sustained.

The materials used were tested by sample beforehand, and the modulus of elasticity determined in each case, so that the theoretical and practical conditions could be compared.

Many ingenious and delicate devices were used for measuring the deformations of the arches at different points under increasing loads, as, under the elastic theory, the deformations should be proportional to the loads until the elastic limit is reached; the importance of exact measurements in this connection was, therefore, very great. The loads were applied at points prepared in the construction of the arches in the form of steps at equidistant points in the span, this form of loading giving a clearly-defined distribution at definite locations, and also corresponding to a satisfactory method of supporting the roadway in actual constructions.

As the method was the same for all the arches tested, an account of one will serve for all. Taking the case of the rubble-stone arch, the load of the arch itself was gradually distributed, the depth of the key being 23.6 inches and at the springings 43.3 inches, while the additional load was applied at six points equidistant from the crown to the springing. The test load was composed of rails piled upon the platforms above, and gradually allowed to descend upon the arch in determinate quantities, the measurements giving the corresponding deflections.

BRICK ARCH. FIG. 4. RUBBLE-STONE ARCH.

FIG. 5. CONCRETE ARCH READY FOR APPLICATION OF LOAD.

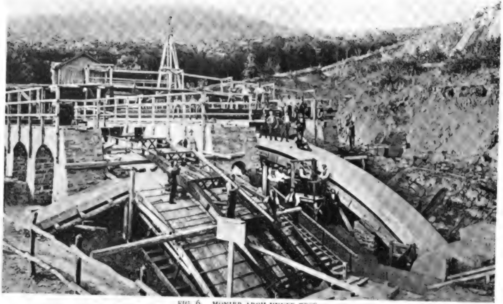


FIG. 6. MONIER ARCH UNDER TEST.

As the loads were applied, the deflections increased almost in direct proportion to the force applied, showing that the laws of elasticity

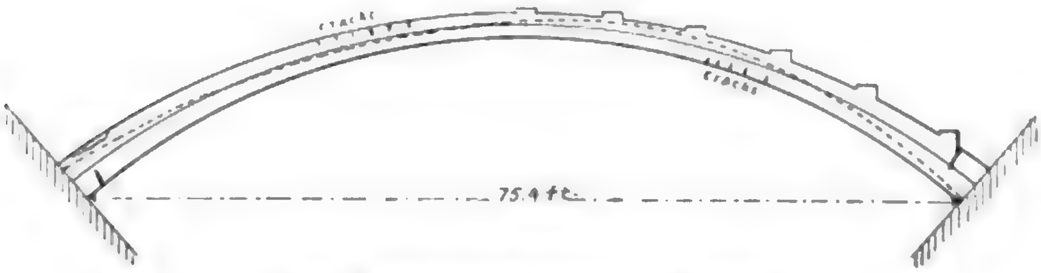


FIG. 7. FAILURE OF MASONRY ARCH.

hold good for masonry as well as for metallic structures, while, after the elastic limit was surpassed and cracks began to form, both the location of the cracks and the point of maximum deformation showed that the position of the equilibrium curve practically coincided with that demanded by the elastic theory. These facts will best be shown by an examination of the arch itself, Fig. 7. The cracks shown began to appear when the one-sided load reached about five hundred pounds per square foot, and in nearly every case they occur at those points furthest from the distorted line of pressure,—that is, at the portions under greatest tension,—and it was at these points that the arch finally failed when tested to destruction with a load of 660 pounds per square foot.

Practically similar results were obtained with the other arches, the differences in strength and distortion being only those due to the difference in material, and the theory being sustained in all cases. In the report, which was jointly prepared by the twelve members of the committee, all the data are given in detail, and the mathematical discussion is worked out in full, while graphical diagrams show clearly how the results of the tests may be applied to the design of future arches.

One of the most immediate results of these exhaustive and valuable experiments was the construction of the great arch over the Pruth at Jaremcze. This is a stone arch of 65 meters' span by 17.9 meters'

FIG. 8. ARCH OVER THE PRUTH.

rise, or 213 feet by 58.6 feet, and has, therefore, a greater span than any other railway arch in the world. The only arch exceeding it is

the Cabin John Arch near Washington of 220 feet' span, but that carries only an aqueduct and is therefore not subject to the action of moving trains. The Jaremcze arch was designed by Inspector Huss,

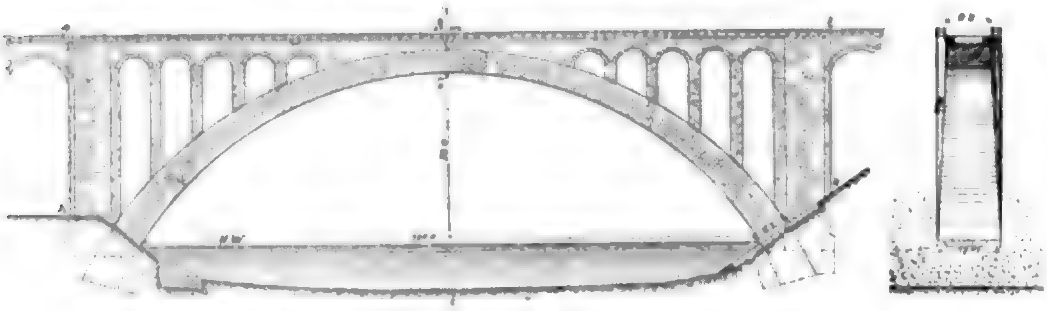


FIG. 9. PROJECTED ARCH OF 120 METERS' SPAN.

directly upon the lines indicated by the results of the tests of the committee, and in its construction the distribution of the load was effected in a manner similar to that adopted in the tests. This fine arch, completed in 1894 at a cost of about $34,000, was the first fruit of the result of the work of the committee, and it is probable that other great arches will be constructed on the same lines.

The report contains a design for a similar arch of 120 meters' span (393 feet). Both the Jaremcze arch and this proposed arch are shown in Figs. 8 and 9, and, while in some particulars the proportions differ materially from those called for by previous methods, the effect is artistically pleasing, while the strength and distribution of material are such as to conform fully to the requirements developed by the tests.

It is a matter for congratulation that the work of the Austrian Society of Engineers and Architects has practically solved the problem of the arch, and enabled both its theory and practice to be established upon a sound and fully-demonstrated basis.

CHARACTERISTIC AMERICAN METAL MINES.

THE MINES OF THE MINNESOTA IRON COMPANY.

By Horace V. Winchell.

FOURTEEN years ago Minnesota was unknown as a producer of iron ore. Last year her mines yielded about one quarter of the entire product of the United States, and her output of 3,970,-000 gross tons of high-grade hematite exceeded that of any other State except Michigan. Spain, Germany, and Great Britain are the only foreign countries which mined more iron ore than Minnesota in 1896, and, when the returns are counted for the present year, both Spain and Michigan may be found in subordinate positions. This phenomenal growth is in large part due to the enterprise and good management of the Minnesota Iron Company in the development and exploitation of the rich and extensive ore deposits of the Vermilion and Mesabi iron ranges.

Organized under the laws of Minnesota November 14, 1882, this company, with a capital of $16,500,000, has so extended its interests and expanded its operations that it is to-day by far the largest producer of iron ore in existence. It also owns and operates about 154 miles of standard-gage railroad; five ore docks, equipped with 743 pockets of a capacity of 120,900 gross tons of iron ore; and nine steel steamers and five barges with a combined capacity of about 50,000 tons. The railroad is operated by the Duluth and Iron Range Railroad Company, and the vessels by the Minnesota Steamship Company.

The seven mines owned by this giant iron ore concern are situated at Ely and Soudan on the Vermilion range, and at Biwabik, Sparta, Eveleth, and Virginia on the Mesabi range. The docks, as well as the shops and round-house, of the railroad company are at Two Harbors, on the north shore of Lake Superior, at a distance of from 57 to 86 miles from the mines.

The railroad was built from Two Harbors to Soudan (67 miles), and the iron mines were opened at the latter place in 1883 by Charlemagne Tower, of Philadelphia, father of our present minister to Austria. The present company acquired possession about three years later.

The names of the mines owned and operated by the Minnesota Iron Company are: the Chandler at Ely, the Minnesota at Soudan near Tower, the Canton at Biwabik, the Genoa at Sparta, the Fayal

Fig. 1.—Map of the Iron Ranges of Northern Minnesota.

and Auburn near Eveleth, and the Norman at Virginia,—all in Saint Louis county, Minnesota.

The Minnesota mines, at Soudan, which were the first iron mines opened in the State, produce a hard and massive hematite ore, which, after being mined, is passed through powerful crushers to reduce it to convenient size; the Chandler mine produces a naturally crushed or granular hard ore; and the Mesabi mines yield soft ores of varying chemical and mechanical qualities. The Minnesota Iron Company

MINNESOTA MINE AT SOUDAN. VIEW OF NO. 8 OPEN PIT AND SHAFT, LOOKING WEST.

is thus enabled to meet almost any requirements, and can supply ore adapted to the manufacture of any grade of iron and steel.

The average analyses of its different ores shipped during 1896 are as follows:

VERMILION RANGE.

Name of Mine.	Name of Grade.	Iron.	Silica.	Phos.	Mang.	Sulph.	Alum.	Lime.	Magn.	Moist.
Chandler	Chandler	64.70	4.26	036	0.13	trace	1.37	.33	.10	5.79
"	Long Lake	60.59	7.80	.040	0.13	.004	1.85	.72	.20	7.55
Minnesota	Minnesota	67.74	1.55	.048	none	none	.90	.27	.12	2.00
"	Soudan	65.31	4.36	.104	none	trace	.68	.62	.28	....
"	Red Lake	64.41	3.74	.108	none	trace	1.81	.35	.11	....
"	Vermilion	67.36	1.68	.156	none	none	.62	.60	.25	....

MESABI RANGE.

Auburn	Auburn	65.04	2.25	.047	0.39	trace	1.47	.68	.15	9.56
"	Audrey	62.69	2.64	.071	0.66	trace	1.52	.25	.14	12.07
Canton	Climax	63.64	1.94	.036	0.87	trace	.60	.88	trace	8.65
"	Canton	60.80	4.25	.048	0.49	trace	.93	.71	.07	9.97
Fayal	Fayal	62.55	3.06	.037	1.00	trace	1.30	.26	.14	9.55
Genoa	Genoa	62.70	3.75	.033	0.65	none	1.16	.60	.19	11.29
Norman	Norman	62.15	3.75	.069	0.90	trace	1.82	.52	.13	8.41
"	Saxon	64.20	3.75	.039	0.56	....	1.21	.12	.04	8.00

MINNESOTA MINE, NO. 8 SHAFT, HOISTING AND CRUSHING PLANT.

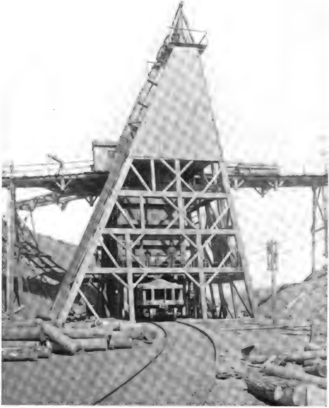
MINNESOTA MINE, NO. 9 SHAFT AND OPEN PIT, LOOKING EAST.

MINNESOTA MINE, INTERIOR VIEW OF COMPRESSOR HOUSE.

In the thirteen years which have elapsed since the first shipments from the Vermilion range the hard-ore mines at Soudan have produced 5,169,071 gross tons of ore; the Chandler mine has sent out 3,793,007 tons; and the Mesabi mines of the Minnesota Iron Company, the earliest known of which was discovered but five years ago and which have been shipping but three seasons, have produced 1,842,504 tons, making a total tonnage of 10,804,582 gross tons, or more than 12,000,000 net tons of iron ore handled by a concern only fifteen years of age. In an age of large enterprises the achievements of this company rank with the greatest.

The Minnesota mine comprises a number of openings in a group of hematite lenses. The enclosing country rock is green schist or slate of Keewatin or Lower Huronian age. The dip of the ore lenses is at a high angle to the north, and their strike is nearly east and west. The ore deposits are of irregular shape and of varying size and quality. Nearly half the ore mined has been of bessemer grade, and very low in sulphur.

Some differences of opinion have existed among geologists as to the origin of these Vermilion range ores, but it is now generally agreed that in their original form they were chemical oceanic precipitates or sediments. Whether they were primarily hydroxids, carbonates, or silicates, or mixtures of these, and whether deposited without or with



CHANDLER MINE, NO. 2 SHAFT AND POCKET.

the agency of organic forms, is not clearly demonstrated. The age of the rocks, and chemical considerations, lead the writer to believe that the iron and silica were chemically precipitated as hydroxids without the aid of organic life. By subsequent rearrangement and alteration the silica was removed, and the iron oxid concentrated as we now find it.

These lenses of ore are found entirely surrounded by the green

CHANDLER MINE, STOCKPILE AT NO. 4 SHAFT, CAVED GROUND TO THE LEFT.

AUBURN MINE, OPEN PIT, SHOWING CRATERS AND FIRST LEVEL DRIFTS UNCOVERED.

schists. They were first found in outcropping knolls, but lenses of good ore that did not come within five hundred feet of the surface have been discovered in the underground developments. Indeed, it is a common practice at these mines to keep boring into the walls with a diamond drill as the work progresses. By this means, when one lense is exhausted, others are frequently discovered near by. The thickness of these ore bodies varies from nothing to a hundred feet or more; their length may be several hundred, or even a thousand feet, and their vertical axis is sometimes as great as their length.

The open-pit method of working was first adopted at the Minnesota mines, but soon gave way to that now in vogue, which seems peculiarly adapted to deposits of this nature, and reflects great credit on its originator. It is called "longitudinal overhand stoping with back-filling." The ore is hard and strong, but the schist walls are weak and treacherous. Shafts are sunk in the foot wall some distance from the ore, but with approximately the same dip, and connected with it by cross-cuts at the several levels. These levels are carried from foot- to hanging-wall, and in the ore are blasted out fifteen or twenty feet high. The gang-way is then covered by timber, leaving the necessary openings for ladders and chutes. Rock is then drawn in from raises in the walls, and piled up above the protected level, until more ore can be won by overhand stoping. When about ten feet more of ore has been blasted down, the rock raise is again tapped, and the filled floor again rises so that more ore can be reached. This process is carried nearly

AUBURN MINE, SHOWING DEPTH OF STRIPPING. SHAFT APPEARS IN BACKGROUND.

AUBURN MINE, SHAFT AND POCKET, SHOWING MANNER OF LOADING CARS FROM POCKET.

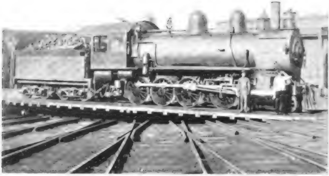
to the level above, a floor of ore being left to support the level temporarily. Diamond drills are used in drilling for back-stoping. The ore is run down into tram cars in the level below, through chutes placed thirty feet apart. Mules are used for tramming in the longer levels, and the ore is hoisted in cages. In the cars in which it is brought to the surface the ore is then run on tracks to the crusher house. Here it is passed through jaws of manganese steel, and thence

FAYAL MINE, BOTTOM OF A TIMBER SLIDE.

[F. W. Denton, Trans. Am. Inst. Min. Eng.]

FAYAL MINE, UNDERGROUND VIEW, LOOKING TOWARD THE SHAFT AND SHOWING THE OPENINGS INTO THE POCKETS.

[F. W. Denton, Trans. Am. Inst. Min. Eng.]



123-TON LOCOMOTIVE, DULUTH AND IRON RANGE R. R.

conveyed to pockets for loading into cars, or to the stockpile. All the ore mined during the winter is stockpiled until spring, and loaded on ore cars by steam shovel during the season of navigation. The average output from this mine has exceeded 425,000 tons per annum, or about 1,350 tons per diem for the past twelve years. It is now apparently in better condition than ever.

The Chandler is the other great Vermilion range mine of the Minnesota Iron Company. Covering but eighty acres, and with half as many shafts and a much smaller force of miners, this mine has produced about 1,500 gross tons per day for the past eight years. The reason for this greater output lies in the fact that the ore is naturally crushed, requiring less drilling and blasting. Moreover, it can be worked by the caving system. In 1896 this mine produced 471,545 tons of ore, every pound of which was of bessemer quality, and seven-eighths of which averaged more than 64.5 per cent. of metallic iron.

Mining here is carried on through shafts in the walls and by a series of main and sub-drifts. With the development and equipment which this mine now has, it can easily produce 70,000 tons of ore per month. Because of its uniform grade this ore is in much demand by furnace men, and many Lake Superior cost records have been lowered

by reason of the steadiness and economy with which the mine has been operated.

The first mine to be opened on the Mesabi range by the Minnesota Iron Company was the Canton near Biwabik. This was in 1892. Since then the Norman, Auburn, Fayal, and Genoa mines have been successively purchased and developed.

The origin of the Mesabi ore is due to the alteration of a rock called "taconite," and its concentration by the action of atmospheric waters in the oxidation of the iron-bearing mineral, and the removal of the commingled silica. This taconite is believed to have been deposited in the waters of the Taconic or Upper Huronian ocean, largely through the agency of foraminifera and the formation of green sand or glauconite. There is a marked contrast between the ores of the Vermilion and Mesabi ranges. That of the former range is in vertical lenses of hard ore; that of the Mesabi is in almost flat beds of fine-grained "soft" ore. Both are high-grade hematite.

The mining problems that have presented themselves on the Mesabi, as distinguished from other soft-ore mines, are those which arise from the flat dip and great area of the deposits, and from the fact that the roof is glacial drift, composed of sand, clay, and boulders instead of solid rock. Owing to the variable thickness of the ore and its covering, (each ranging from 10 to 200 feet or more) as well as to its

DULUTH AND IRON RANGE ORE CAR, CAPACITY 25 TONS.

ORE TRAINS IN YARD AT TWO HARBORS, MINNESOTA.

TOP VIEW OF ORE DOCKS, SHOWING POCKETS AND METHOD OF UNLOADING ORE TRAINS.

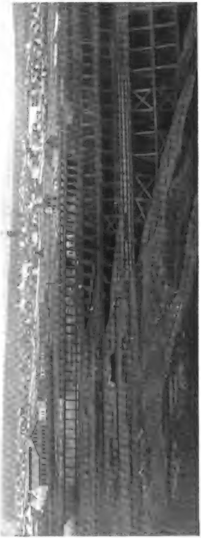
varying quality and the irregular shape of the lenses, there have been many more or less novel methods of mining proposed. The removal of the glacial drift which covers the ore, or "stripping," by steam shovels, is the common method where the ore body is not too deeply buried, and when it possesses sufficient depth and area to warrant the large initial expenditure. It is now considered advisable to strip where the ore is three times as thick as the covering. About one-half the Mesabi output for 1896 was from open-pit mines, and the percentage will be larger for the present year.

There are two methods of excavating the ore and placing it on the car: (1) the "milling"; (2) the steam shovel method. In the former method shafts are sunk near the boundary of the ore deposit. From these shafts levels are driven at any desired depth into or under the stripped ore. Timbered drifts are then run into the ore from the main levels. From these drifts raises are put up to the surface, and the ore is milled down into them by workmen on top. Tram cars hauled by mules or by men convey the ore from these raises to the shafts, where it is hoisted in skips to the surface. In the steam-shovel method railroad trains are run upon tracks laid on the uncovered ore, and the cars are filled by steam shovels, which load the soft hematite directly from its natural bed.

Of the mines owned by this company on the Mesabi, the Canton,

THE MARICOPA LYING AT AN ORE DOCK, TWO HARBORS.

VESSELS LOADING AT TWO HARBORS DOCKS.



D. AND I. R. R. DOCKS, SHOPS, AND ROUND HOUSE AT TWO HARBORS, MINNESOTA.

Fayal, and Genoa are regular underground mines, while the Norman and Auburn are operated by the stripping and milling process.

The output per man employed is very much greater in the milling system than in any other in which the ore is moved chiefly by manual labor. Thus, while from four to six tons per day for each man employed is a satisfactory output for underground mines, it is nothing unusual for the production at milling mines to average forty tons per day for all men above and below ground, and twice this amount has been mined for short periods under favorable conditions. The scene at the Auburn mine is quite picturesque. The open pit in which the ore is being milled presents the appearance of some volcanic crater, while the men engaged in shovelling and sliding the ore down into the apparently insatiable holes in the ground look like imps of the devil feeding the internal fires. The white smoke which emerges from the dark ore after a blast completes the illusion. The Auburn is the finest example of a milling mine on the Mesabi, and is well worth visiting.

The Fayal mine is already one of the largest and most completely developed in the Lake Superior region. A producer for only two years, and that mainly of ore taken out in development work, it is a good example of what money and brains can accomplish in a short time on the Mesabi range. Miles of underground levels and drifts, all arranged with a view to maximum output at minimum cost, lead the visitor past millions of tons of ore all ready for mining. Ingenious and labor-saving devices and methods abound on every hand, and the plan of the mine is as nearly perfect as study and experience can make it. The future of such mines as these may certainly be regarded with complacency by their owners.

The limits of this article will not permit particular mention of all the Mesabi mines of the Minnesota Iron Company. It is sufficient to repeat the remark made to the writer by the editor of a prominent eastern iron journal while travelling through the district recently: "You may know a mine of the Minnesota Iron Company at a glance by the air of systematic and thorough neatness and order apparent on every side." Certainly the writer has never seen finer or more efficient mining plants. Probably one reason for the general tone of its affairs is the good judgment displayed by the Minnesota Iron Company in the choice of superintendents and foremen. The fact also that considerable latitude is given to these men in exercising their individual tastes and displaying their ingenuity and originality may have something to do with it. Still, there must be something back of all this, and it probably lies in the strong personality of those responsible for the general management.

The Duluth and Iron Range railroad, under the direction of Mr. J.

L. Greatsinger, is as efficiently and systematically operated as the iron mines. A standard-gage mining railroad is perhaps common enough. But to find one with 154 miles of main line and 60 more of side tracks, laid with 80-pound rails, owning some of the finest rolling-stock ever built, consisting of 58 locomotives (12 of which are 12-wheel locomotives weighing 123 tons each), 2,298 ore cars, 434 box, flat, and other freight cars, and 14 passenger and express coaches, is certainly worthy of special comment. These cars and locomotives are kept busy during the season of lake navigation, as will be seen from the following statement of the business done in 1895:

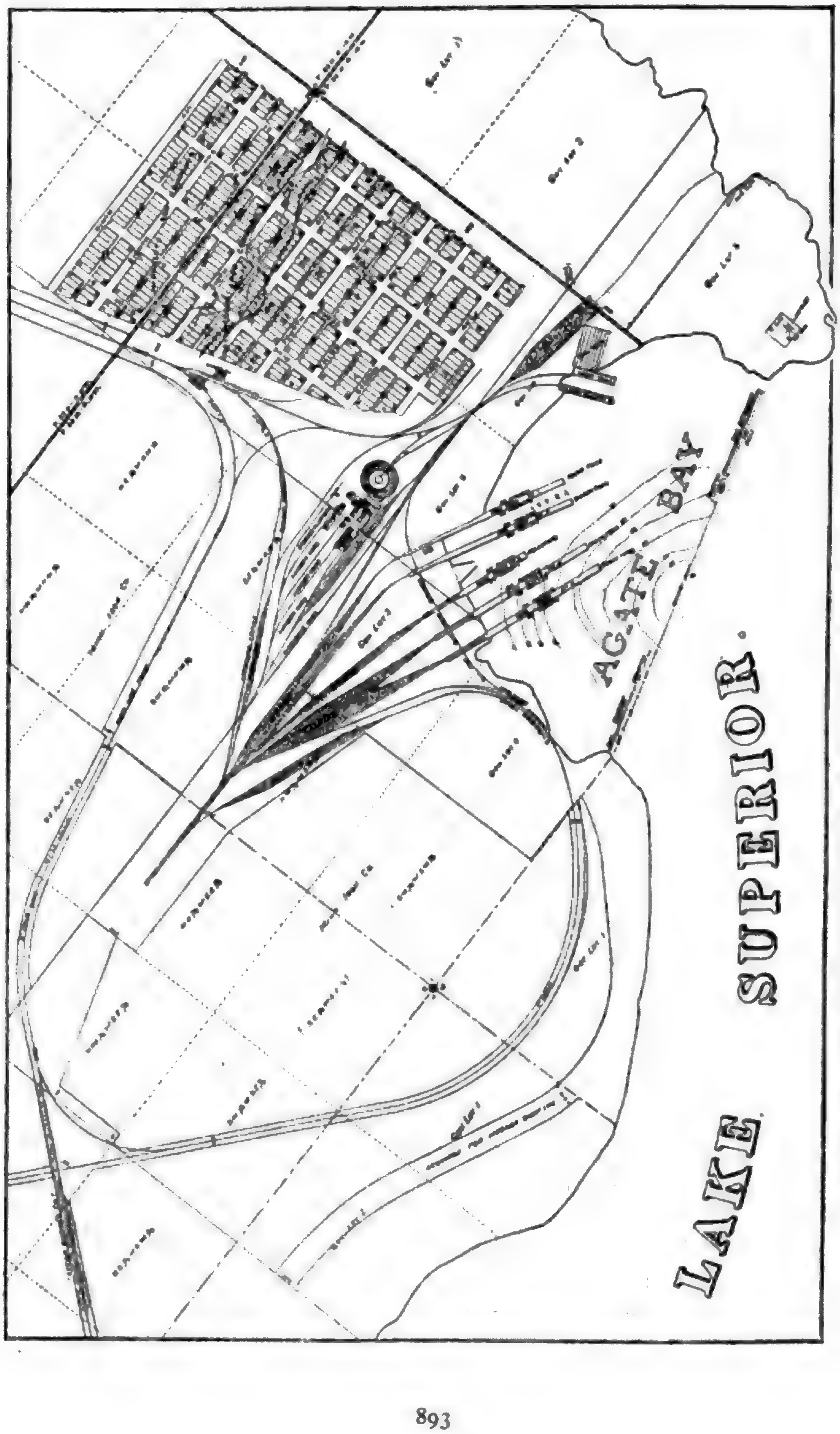
Passenger earnings	$ 69,258.01
Freight "	1,488,337.44
Mail "	7,218.72
Express "	6,000.00
Miscellaneous "	5,453.02
Total [$9,592.66 per mile]	$1,576,267.19

The business done in 1896 was considerably in excess of that of 1895, and this season is thus far ahead of any former year.

All ore cars are built with hopper bottoms for dropping the ore into the pockets of the docks. The latter are from 45 to 54 feet above the water, and the ore slides from the pockets through iron chutes into the holds of the vessels. The speed with which vessels are loaded and unloaded is little short of marvelous. Vessels frequently load and depart with a cargo of 3,500 or 4,000 tons within two hours from the time they reach port. One record has been made of 2,350 tons of ore loaded in forty-five minutes. From 15,000 to 40,000 tons of ore are handled daily at Two Harbors with a force of men that at first sight seems totally inadequate. The design of the yard and the approach to the ore docks at Two Harbors is said to be a remarkably fine example of railroad construction, and in the handling of large and irregular volumes of traffic this little iron ore road sets an example that could be studied with profit by more than one trunk line.

From Two Harbors to Cleveland, the principal iron-ore market of the central west, the distance is about 800 miles. For carrying their ore to Lake Erie ports the Minnesota Iron Company, through its associated corporation, the Minnesota Steamship Company, owns a fleet of nine steel steamers and five barges. The names of these vessels and their carrying capacity in gross tons on a draft of fifteen and a half or sixteen feet of water are as follows:

Marisca, Manola, and Maruba, about 2,500 tons each; Masaba and Marina, about 2,700 tons each; Mariposa and Maritana, 3,400 to 3,500 tons; Maricopa, 4,500 tons. The barges are: Marcia and



TERMINALS AND DOCK YARDS OF THE DULUTH AND IRON RANGE RAILROAD AT TWO HARBORS, MINNESOTA.

Malta, each carrying 4,000 tons, and the Martha, Manda, and Magna, each carrying 4,500 tons.

The combined capacity of the fleet is thus nearly 50,000 tons per trip, or slightly less than a million tons during the season. At the average season rates for the past ten years ($1.16) this fleet is capable of earning more than a million dollars per annum on eastward-bound freight alone. With deeper water between lakes Superior and Huron the size of the cargoes can be materially increased.

There are many interesting features connected with the general scheme of operations of this company. As already stated, order is the watchword in every department. At the warehouses of the different mines, for example, an exact account is kept of the disposition of every article, no matter how small or inexpensive. Each miner is charged with every candle or implement that he removes. Where so many are employed, little losses would soon aggregate a great deal.

Sick or disabled miners are cared for in the hospital of the company by the company physician. For this privilege each man pays one dollar per month, and is treated free of any other charge as often as may be necessary, with hospital privilege for six months in case of injury.

There is also a benefit fund, to which each man contributes forty cents per month, and the company adds an equal amount for each laborer on the pay-roll. In case of injury a single man receives $15 and a married man $20 per month for six months, if the injury lasts so long. In case of death, $500 is paid to the heirs.

A large number of comfortable houses have been built at Soudan by the company. These are rented at a low rate to the employees. On some occasions during the past four years, when there has not been work for all the men, they have been permitted to occupy these houses rent-free, and also been allowed to cut firewood, free of charge, on lands belonging to the company.

Educational matters are carefully looked after among the mining communities, and a large school house was built and equipped by the company at Soudan. The salaries of three and a half teachers are also paid from the regular monthly pay-roll of the company.

No stores or saloons are allowed at Soudan. They are all located at Tower, some two miles distant. Delivery wagons from the latter place take orders and deliver goods daily at the mining location. At Ely and on the Mesabi range, where other mining companies are interested, and the land has a variety of owners, it is impossible to arrange matters as they are arranged at Tower and Soudan. Liberal provision is usually made, however, regarding school and hospital matters at all the mines, and at Two Harbors for the railroad employees.

The number of employees of the company in its mining operations alone is about 2,400 at the present time. It varies from 1,200 to 3,000. The miners are chiefly Austrians and Finlanders. The latter are considered the more intelligent. The only strike that the Minnesota Iron Company has ever had was caused by a difference of opinion over the observance of an optional Roman Catholic holiday. That strike lasted but two and a half days. There has never been any trouble over wages or hours of labor.

Offices of this company are maintained at New York, Cleveland, Chicago, Duluth, and Soudan. The president and general manager, Mr. D. H. Bacon, resides at Tower. To him more than to any individual is due the wonderful success of the Minnesota Iron Company, and it is generally admitted among those familiar with this industry that he is without an equal as a manager and organizer, as well as in his complete familiarity with the iron-ore business.

Possessed of seven magnificent iron mines, and owners of a complete line of transportation to carry its ore to market, this company is to-day able to force its way into the ore market, and hold its share of business against any competitors. It has already, July 1, sold 1,882,000 tons of ore for this year's delivery, and its mines will probably produce a total of 2,200,000 tons. Their producing capacity is not less than three million tons, and the railroad and docks can handle three and a half millions.

If the demand for iron continues to increase, we may soon have one company up in the North Star State producing as much iron ore as all the mines of Spain, or even of Germany.

ISOLATED ELECTRIC PLANTS VERSUS CENTRAL STATIONS.

By Percival Robert Moses.

II.

IN the two groups already described, power for elevators is a small factor of the total required for all the purposes of the building. In the office-building, on the contrary, the power required for elevators is frequently greater than that needed for all other purposes. The heating requirements are severe only while the tenants are occupying their offices. As more steam is needed for heating than would be used for lighting the building, the coal bills in winter are not increased by the demand for light; but, in summer, the production of light requires some additional coal. It is these factors, with their requirements of skilled labor, that enables the isolated plant to completely control the situation in all office-buildings constructed at the present time. In few of the examples cited would the abolition of the lighting plant reduce the annual expenditure for labor by more than the wages of a fireman.

The central-station supply has a field in many of these buildings in supplying light and power during the hours of partial operation. Buildings similar in character (see tables) containing electric elevators have a fuel-consumption slightly less than that of those containing hydraulic machines. This is to be expected, on account of the partial conformity of the power required to the load raised in the electric machine, and the absence of such regulation with the hydraulic machine.

Compare Nos. 1 and 2. These buildings are adjoining and well-situated, and they cater to the same class of tenants. No. 1 does not include light in the rent; No. 2 does. No. 1 runs 10 hours; No. 2, 12 hours. No. 1 has two steam elevators; No. 2, one high-speed hydraulic elevator. The total extra cost imposed on No. 2 in order to give "free electric light" is about $1,300 a year, $150 for fuel, $480 for labor, and $600 for interest (5 per cent.) and depreciation (10 per cent). There is a floor area of about 50,000 square feet available for renting, so that the rents would have to be raised 2.6 cents a square foot per year to pay for the plant operation. At this rate an office 20×20 would be assessed less than a dollar a month.

Compare, next, Nos. 3 and 4. These are more nearly alike in available floor space than their dimensions indicate. No. 4 has a

TABLE III.—GROUP III.

No.	Character Building.	Dimensions. H.	W.	L.	Stories.	Total Lights.	Average Load.	Est'm'd cost Plant.	Fuel, cost per day	Elevators. E S H	Speed	Plant Operation, cost per year.	Items Included in Rent	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost
1	Office (Old)	85	75	175	7	500 (Est.) Gas	—	—	4.50	— 2. —	Slow	2300.00	Heat, etc.	1	—	—	10	Reduced Direct Press	Furn'ce	2300.00
2	Office (Old)	85	50 25	125 125	7	500	300	2800	4.85	— — 1.	Fast	3000.00	Heat, Light, etc.	1	1	—	12	Exhaust and Live	Pea	3000.00
3	Office (New)	120	60	45	10	800	300	3000	3.25	— — 2.	Fast	3300.00	Heat, Light, etc.	1	1	1	10	Exhaust	Pea	3300.00
4	Office (Old)	80	75	100	6	600	200	—	5.25	— — 2	Slow	(P) 3100.00 (L) 2400.00	Heat, Light, etc.	1	1	—	10	Reduced Direct Press.	Furn'ce	5500.00
5	Office (New)	150	50	40	13	800	250	4000	2.85	2. — —	Medium	3000.00	Heat, Light, etc.	1	2	—	12	Exhaust	Pea	3000.00
6	Office (New)	150	60	50	13	800 (Est.)	75	—	3.75	2. — —	Fast	(P) 3000.00 (L) 2500.00	Heat, etc. Light in Private Offices.	1	1	1	12	Exhaust	Pea	5500.00
7	Office and Newspaper	125	100	110	10		900	5000	30.00	— 1. 2	Fast	16000.00	Heat, Light, Steam for Presses.	3	3	—	24	Exhaust	Pea	16000.00
8	Office and Telegph.	225	80	150	14	3000	1000	14000	26.00	6. — —	Fast	28000.00	Heat, Light, etc.	4	6	7	24	Exhaust	Furn'ce	28000.00
9	Office	180	80	110	15	1000	300	12000	9.00	5. — —	Fast	8000.00	Heat, Light, etc.	3	2	—	10 full	Exhaust	Pea	8000.00
10	Office	150	50	125	13	1200	300	5000	7.50	— — 3	Fast	5800.00	Heat, Light, etc.	3	1	—	10(f) 7(p)	Exhaust	Buckwheat	6000.00
11	Office	150	40	120	12	1400	—	7000	5.00	— — 3.	Fast	5300.00	Heat, Light, etc.	2	2	1	12(f) 12(p)	Exhaust	—	5300.00

TABLE IV.—GROUPS IV AND V.

No.	Character B'lding	Dimensions. H.	W	L.	Stories.	Total Lights.	Average Load.	Fuel, cost per day	Est. c'st Light. Plant	Elevators. E. S. H.	Plant Operation, cost per year.	Ice Supply.	Character of Business.	Labor. Eng	Firemen	Others	Hours Service	Heating System.	Coal Used.	Total Annual Oper'g Cost.
1	Club	60	75	75	3	900	?	4.25	3000	—	35000.00	Company	Social	2	1	—	24	Exhaust	Pea	3500.00
2	Restaurant	60	25	150	3	250	150	—	—	—	(P) 550.00 (L) 2000.00 (H) 700.00 (I) 1200.00	Company	High-class Restaurant	1	—	—	18	Direct	—	4450.00
3	"	50	150	100	3	750	60 (D) 350 (N)	5.25	4000	—	(P) 4000.00 (I) 1200.00	Company	"	2	1	—	24	Exhaust	Pea	5200.00
4	"	50	50	100	3	500	60 (D) 450 (N)	4.50	—	—	(P) 3000.00 (L) 5000.00	Machine	"	2	—	—	20	Exhaust and Live	Pea	8000.00
5	Store	60	150	175	4	100 inc. 6 arcs 250 gas	—	6.00	—	1. 1. 1.	(P) 2500.00 (L) 1800.00	—	Dry Goods	1	—	—	10	Direct LowPres.	Broken	4300.00
6	"	90	90	80	7	450 inc.	—	Excess 0.80	3700	— 2. —	(Excess) (P) 1025.00 (L) 240.00	—	Wholesale and Retail DrugHouse	1	1	—	12 (full)	—	Broken	Excess 1253.00
7	Loft	75	25	50	6	—	—	1.00	—	1 — —	(P) 375.00 (L) 180.00	—	Various	—	—	—	10	Direct	Pea	555.00
8	"	75	40	75	6	125	90	2.50	1500	— 1. —	800.00	—	Commission	—	—	—	10	Direct	—	800.00
9	"	100	100	125	9	1200	400 (D)	8.64	6000	— — 6.	7000.00	—	Wholesale Dealers	3	1	—	15	Exhaust	Broken	7000.00

large restaurant, the cost of lighting which was formerly included in the rent. No. 3 has an insurance company requiring a large quantity of light. Otherwise the conditions are similar. No. 4 uses expensive pea coal and wasteful old-type elevator pumps and boilers; No. 3 uses three-watt lamps, high-speed modern hydraulic elevators, and new boilers. No. 4 obtains light from a central station; No. 3 has a private plant. No. 4 heats with steam at reduced pressure; No. 3 uses exhaust steam entirely. Labor in No. 3 costs about $850 a year more than that in No. 4. On the other hand, coal in No. 4 costs $600 a year more than that in No. 3.

By the use of modern machinery and exhaust heating the plant of No. 3, including lighting, is operated at a cost exceeding by $250 a year that of operating the plant of No. 4, excluding lighting. No. 4 gives free light, and, although well situated, is half empty; under present arrangements, the restaurant pays for its own lighting, and has had its rent reduced. The bills for lighting averaged more than $200 a month with the building filled, showing a gain for No. 3, exclusive of interest and depreciation, of $2,150 a year. Deducting the fixed charges, at 15 per cent. on the cost of the generating plant, the net gain shown amounts to $1,000 a year,—enough to pay for the plant in two years.

Nos. 5 and 6 can also be compared. The latter is about to install a lighting plant, but the present conditions will serve. The buildings are about the same size, each having two elevators. No. 5 gives free light throughout; No. 6 supplies offices, but not the stores or the club (at present), with a consequent loss of rental. In No. 5 the elevators and lights are supplied from the same generating set, except at periods of large lighting-load; No. 6 has both its elevators and lights on the central service. Both buildings are exposed, and have a large heating factor. The cost of operation of the two plants is the same, and, in addition, No. 6 pays $2,500 a year for light and power, and also a portion of the rent.

No. 7 is interesting; it is a newspaper building, with an old high-pressure heating plant remodeled, large engines intended for 12 pounds, back pressure, etc., two hydraulic high-speed elevators, and one steam drum elevator. It has a day load of 500 lights and a night load of 1,000. Boilers supply steam for the presses of two newspapers, and light for one. Ten tons' pea coal, costing from $2.85 to $3.00 a ton, are used per day. One chief engineer, two assistants, and three firemen are employed. The total operating cost of the engine room and plant, everything included, is less than fifty dollars per day. The lighting of this building was placed on the central-station service as a test of comparative economy and at the rates then prevailing,

$0.006 per lamp hour. The lighting alone cost more than the entire operation of the plant at present.

Throwing the lighting on the central service saved nothing in the cost of the labor, and but a very small portion of the cost of the fuel.

No. 8 shows the effect on operating cost of varying conditions. It is a telegraph building, and requires continuous, arduous service. The labor charge is enormous, due to the skilled labor required, and the coal bill becomes of small (comparative) account. The removal of the lighting plant would reduce the force employed by two men only and the coal bill by less than one-half, while the cost from the central service would amount to more than $25,000 per year.

No. 9 is an example of a building in which the power for elevators is greater than that required for the rest of the equipment. It has fifteen stories and contains more than three hundred separate offices, requiring little artificial light and considerable heating. There are five elevators, whose average speed is more than 400 feet a minute. The total coal-consumption is less than three tons of pea coal per day, and the average current used during the ten hours of full service is 300 amperes. At one cent per ampere-hour for both light and power this service would cost about $9,000 a year, or $1,000 more than the present total operating cost. The removal of this isolated plant would decrease the annual labor charge $1,000, and the coal bill one-third, or $900, adding $2,100 a year for interest, depreciation, and taxes; the total annual reduction would be $4,000,—a loss to the owners of $5,000 a year. While this coal charge is small, it will be lowered by the employment of an auxiliary storage battery for regulation and to supply the night load. It is the intention of the owners to install such a battery, and to remove the present connection with the central station which supplies the night requirements,—one elevator with infrequent service and a dozen lights,—at a monthly charge of fifty dollars.

To arrive at a fair estimate of the value of a storage-battery adjunct compare No 11, which contains such a battery, with No. 10. Each has three hydraulic high-speed elevators and an approximately equal floor space. The labor does not enter as a factor in the comparison, as it is not varied by the presence of the auxiliary battery. The difference shown is due to local conditions. The fuel-consumption in No. 11 is two-thirds of that of No. 10,—a difference of $750 a year. The installation was justifiable, provided the cost was less than $4,500. No. 11 is not a building best fitted for a storage battery, as the hydraulic elevators require a double shift of labor and continuous operation of the plant,—reducing the possible economy to the fuel alone. In No. 9, containing electric elevators, the difference in operating costs would

be increased by the amount of the central-station charge and decreased depreciation of machinery. In addition, the regulating property of the battery permits the operation of the generators at or near their full load, and reduces the number of units required by one third. The cost of a suitable battery and appliances for No. 9 is $5,500, and the value of the generating set displaced $3,000, making the total investment $2,500. The annual depreciation will not exceed 10 per cent. or $400. The saving in coal consumption will be about one-third, or $900, less the coal used in recharging the batteries,—cost $180; the cost of the central-station service adds $600—a total return of $920 a year, or 37 per cent. on the investment.

Groups IV and V do not allow of any definite conclusions; each case requires special consideration. In general the central-station supply is advantageous where the maximum load is comparatively large and of short duration, as in loft-buildings, stores, private houses, and small restaurants. The reverse is true where the load is continuous and equivalent to 70 lights burning 10 hours per day. Under such conditions an isolated plant can be installed to compete successfully with the central station, but the plant must be designed to meet the requirements. Other considerations, as in apartment-houses, frequently decide the question; for example, divided leasehold, lack of space for plant, presence of combustible material, lack of proper means of ridding the engine room of smoke and hot air, uncertainty of tenure, etc., overrule any possible economical advantages.

No. 1 is a social club frequented by the best class of people. The plant was designed to meet the requirements, and the results have been eminently satisfactory—to the club at least. Previous to the installation of the plant, the current for the lights was supplied by a central station. The cost of this supply was one thousand dollars a year more than the total expense of operating the present heating and lighting and elevator plant—everything included. The charge necessitated by the introduction of the lighting plant was confined to an increase of the labor cost by $45 a month and the coal bill by a small amount, the heating being accomplished by exhaust instead of by live steam. The boilers previously in use remained. The club is one of moderate size, and is representative of others.

Nos. 2, 3, and 4 are restaurants, all successful, differing from each other in details. Nos. 3 and 4 are comparable, though the latter has about one-quarter the floor space covered by the former. No. 3 contains a lighting and heating plant; the ice is purchased. No. 4 has a heating and refrigerating plant, and buys the light used. The proprietor of No. 3 expects to install a refrigerating plant in the near future, and thereby economize in the general operation of the restau-

rant. Each establishment has large display signs containing more than two hundred lamps (eight c. p.), and is well lighted inside.

No. 4 has a smaller number of lights, but uses them more profusely. As will be seen in table IV, No. 3 employs one fireman extra, and the coal costs seventy-five cents a day more than in No. 4. The coal used for the ice machine in No. 4 costs less than one dollar a day. Combining these figures, we see that the addition of an electric-lighting plant to No. 4 would not cost more than $1.25 a day for labor and $1.75 for fuel,—that is, $3.00 a day, or $1,100 a year. The interest and depreciation would be $375. The present bills for light approximate $5,000 a year. This indicates a possible saving of about $3,500 a year in the yearly cost of operating No. 4. This is less than the amount that has been saved in No. 3 each year since the installation of the plant.

No. 5 pays from thirty to forty-five dollars a month for its one electric elevator; its bills for light average more than $115 a month, or a total of $1,800 a year for both services. The extra labor required for a lighting plant, in addition to the present heating plant, is that of a helper at a dollar a day. No more coal would be required in the winter than at present. In summer very little lighting is necessary, and a quarter of a ton a day would be a large allowance, adding one dollar per day for interest and depreciation. The total cost of operating the lighting plant is $3.00 a day,—a net gain to the establishment of $900.

No. 6 is a large wholesale drug store, with a storage-battery auxiliary. Previous to the installation of the plant, the old building, four-fifths the size of the new one, was lighted first by a gas company, and afterward by an electric light company. The monthly bills varied from more than $100 in summer to $200 in winter,—average, $150, —a total of $1,800 per year, making, for this rate, $2,250 a year. With the installation of an isolated plant (cost, $3,700), the labor charge was increased $728 and the fuel charge $320; the gas bills were reduced to $240 a year. The total annual expenditure was $1,288. Adding 10 per cent. of cost of plant for depreciation,—*i. e.*, $370,—the annual cost of the light is $1,658. The difference ($592) between this sum and $2,250 is exactly sixteen per cent. on the original investment. The economy due to the storage battery in this instance proceeds from the long hours required in the retail department and the small number of lights necessary there. A point of especial moment in this connection is the fact that increasing the hours of burning adds to the total only by increasing the coal bill; that is, doubling the hours of lighting increases lighting-cost only one third.

No. 7 is a very prevalent type of building, and shows clearly one

central-station position that is unassailable, unless by a combination of many adjoining houses. In it the elevator is run from a central-station service, and the lights are paid for directly by the tenants. The elevator boy (who is to be required in New York to have a license as fireman) runs the heating plant (low-pressure boiler) in winter, and also attends the elevator. In larger buildings of this type an engineer-fireman is sometimes employed. The cost of the power for operating the elevator is $10 to $45 a month, and, together with the cost of the coal used in winter and the wages of the elevator boy, constitutes the total operating expense. In many of the larger buildings the whole plant is controlled by the tenants. In such cases the isolated plant may prove advisable, if proper arrangements can be made for division of the cost.

No. 8 is a commission house previously supplied by a central station, but at present using a gas engine belted to dynamo and belt screw elevator. The elevator man cares for the engine without extra pay. The cost of gas and sundries used is $2.60 per day (see table). The interest and depreciation on the machinery (5 per cent. and 10 per cent.) amount to seventy-five cents a day more. Total, $3.35 per day. The lights are required continually. The cost from the central station was nearly $5 a day for illumination alone. An elevator similar to the one used costs elsewhere twelve dollars a month for power. Hence the power and light equivalent to that furnished by the gas engine would have cost monthly more than $140 in contrast to $87. The saving produced paid for the plant in less than three years.

Before concluding, some reasons accounting for the advantage of the private lighting plant in many of the cases instanced will not be out of place. It has been claimed—and the contention is still maintained—that, on account of concentration of machinery, etc., in one large plant, under a trained engineer, the power required for lights, elevators, etc., should be produced and delivered more cheaply than in a number of small stations controlled by less competent men.

The question of the interest on the enormous cost of feeders and mains has been threshed over and over, as well as the other financial points involved, and it would be useless to renew the discussion. What requires emphasizing is the fact shown in the tables, compiled as they are from three times the number of plants cited, that the isolated lighting plant, *per se*, is not what we have to deal with in modern buildings. It is not required that a plant be installed with boilers, stack, engines, dynamos, etc., necessitating additional outlay for engine and boiler-room and an extensive staff engaged merely for the purpose of having the buildings properly lighted. The staff, with

the possible exception of some cheap labor, and everything but the engine and dynamo are essential, without the lighting plant, in all buildings requiring elevators and steam heat.

Again, the tables show little difference in the coal-cost, whether a lighting plant is installed or not. This is readily understood when it is remembered that the lighting required in summer varies from one-sixth (in apartments) to one-half (in hotels) of that required in winter, and that during the winter the steam used for heating, if not obtained from the exhaust of the engines, must be generated directly. That "repairs are so expensive" is another point often brought up. In all the lighting plants, installed under competent advice, that have come under my notice there has not been one in which the repairs required amounted to more than fifty dollars a year in actual cash expended. The ordinary simple engine direct connected to generator need never get seriously out of order, if proper attention is given to it, and the necessary repairs can be made by the engineer.

Correct design of a plant is a most important factor in its economy. Generally a dynamo capacity equal to the maximum load is sufficient, as the small day load allows of inspecting and repairing one of the two or more units into which the installation should be divided. The units should not be of the same size, but each of sufficient capacity to enable it to operate the lights, etc., during a portion of the day with an economical steam-consumption. If electric elevators are employed, some slow starting device or storage batteries must be used, in order to obtain both light and power from the same generating apparatus without causing annoying flickering in the lamps.

The deduction to be drawn from the figures cited are self-evident, and may be summed up as follows. The central-station service can successfully compete with the private supply in small installations, whether separate or aggregate, and in large installations where the load is large and of short duration. In all other cases the power can be delivered more cheaply by the private plant on the premises, though local influences may make its installation inadvisable.

FIFTY YEARS OF ADVANCE IN MARINE ENGINEERING.

By Ridgely Hunt.

THE number of merchant steamers of 100 gross tons and upwards, in the world, exceeds 13,600: their total gross tonnage is more than 17,800,000. By gross tonnage is meant register tonnage,—borne on the books of the custom houses; it expresses in tons of 100 cubic feet the volume of the spaces actually available in a ship for remunerative service, such as the conveyance of passengers or the stowage of cargo.

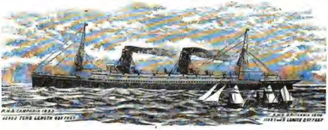
The 13,600 steam vessels may be classified, according to the material of which their hulls are constructed, into about 1,200 wooden, 6,400 iron, and 6,000 steel steamers. It is interesting to know that this vast fleet is but a generation old, the result of a development begun and expanded to its present proportions entirely within the last sixty years. Even the material of which the modern steamship is built is a production of to-day, for, though steel was introduced in 1873 as a ship-building material, it was not generally accepted as such until 1880. Ten years before this, iron was adopted instead of wood, notwithstanding the fact that for fifty years—the first iron steamship having been laid down in 1838—iron had been strongly advocated. Wood, of course, has been in use from time immemorial.

The cardinal advantages which iron possesses over wood as a material of which to build ships are lightness and strength. In ordinary merchant steamers the saving in weight of a hull of iron over one of wood is about 30 per cent. Mr. W. H. White, in his "Manual of Naval Architecture," explains the matter as follows:

As an illustration, take a tie-bar of oak one square foot in sectional area; it would have an ultimate tensile strength of about 570 tons, but would only be trusted with a moving load of 55 to 60 tons. An iron bar of equal weight would have a sectional area of one-ninth square foot and a tensile strength of 320 tons, but, owing to its superior elasticity and the confidence felt in its uniformity of strength, it would be trusted with a load of from 65 to 80 tons. Or, to state the comparison somewhat differently, an iron bar capable of safely sustaining the same load as the oak bar need only have an ultimate tensile strength of 260 tons, which would be equivalent to a sectional area of 13 square inches. The oak bar would weigh 54 pounds per foot of length; the equivalent bar of iron would weigh about 45 pounds per foot of length.

Steel is a superior metal to iron because of its greater strength and elasticity, by virtue of which it can be trusted to stand heavier strains. In building ships of steel there is a saving of weight over iron of about 15 per cent.

The other advantages of steel over iron and, in turn, of iron over wood, in the way of durability, method of construction, and safety, are apparent from what has been said. What is more important to notice here is the influence that the adoption of metal for shipbuilding has had in tending to develop the modern steamship as exemplified in those vessels of gigantic proportions to day steaming into and out of our ports with the speed of locomotive trains. It is impossible to imagine that such vessels could be achieved in wood.

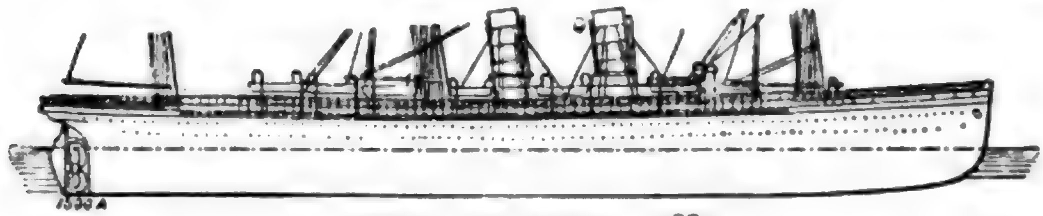


THE FIRST AND LAST CUNARDERS.

THE GREAT EASTERN AT SEA.

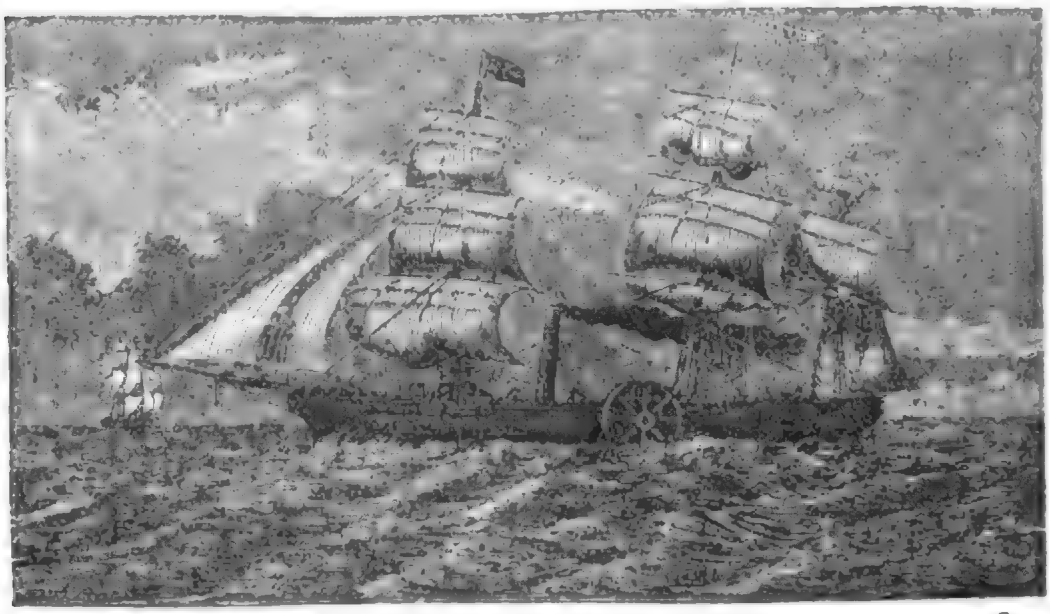
In the last half-century also engines have advanced from simple to

compound, and then to triple-expansion; so, too, have paddle-wheels been discarded for single propellers and for twin propellers; so, too, have single rectangular boilers with one flue, been replaced by several



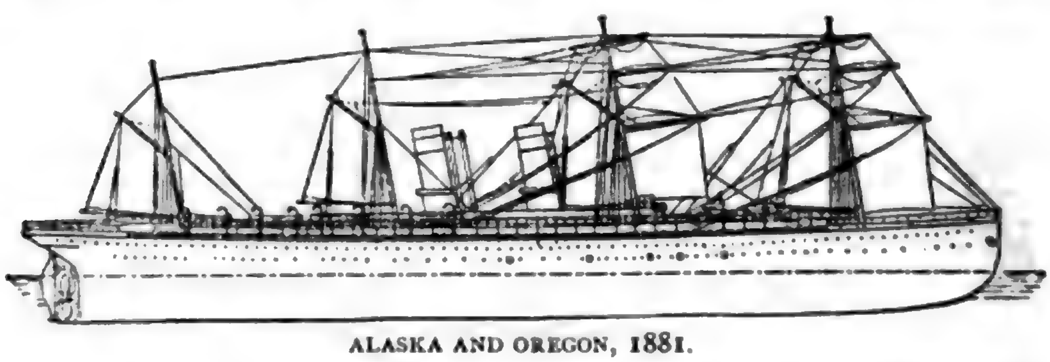
UMBRIA AND ETRURIA, 1884.

boilers, cylindrical, and with many tubes; so, too, have jet condensers been transformed into surface condensers, and the steam pressures



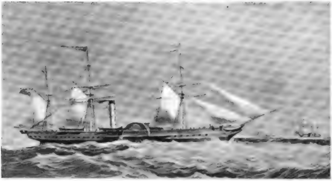
THE SAVANNAH OFF CAPE CLEAR, JUNE 17, 1819.

been raised from 10 to 100 and 200 pounds to the square inch; the size of steamships has been multiplied twentyfold and the horse



ALASKA AND OREGON, 1881.

power fortyfold. The speeds of the ships have been increased from 8 to 17 and 23 knots; and in every other respect has there been

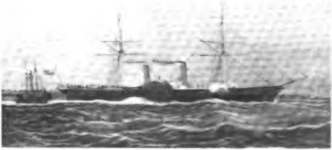


CUNARD ROYAL MAIL PADDLE STEAMSHIP BRITANNIA.

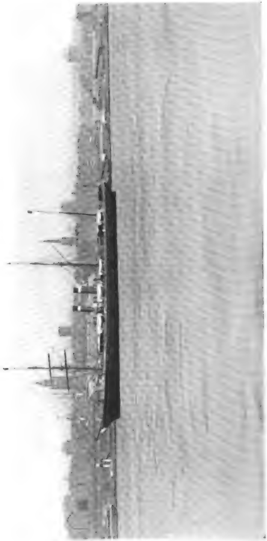
207 ft. x 54 ft. 4 in. x 22 ft. 6 in. 1154 tons, 740 I. H. P. Built on the Clyde 1840. Cargo capacity, 225 tons, and she carried 115 cabin passengers.

a like extraordinary evolution. It is the purpose of this paper to indicate briefly how some of these conversions were effected.

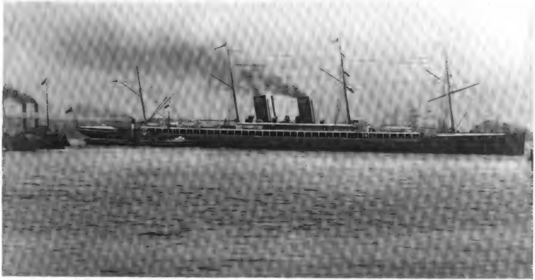
The first commercially-successful steamboat in the world was Fulton's Clermont, in 1807. The first steamship to go into deep water was the Savannah, in 1819. The next, in 1825, was the English steamship Enterprise, from London to Calcutta. Next, in 1829, a ship steamed from England to the West Indies, and then, in 1833, the Royal William (built in Canada), steamed to England. The wisdom of employing such vessels for ocean traffic was much questioned, many



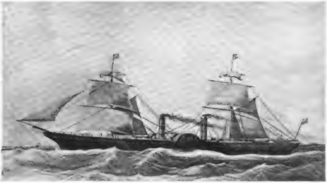
CUNARD ROYAL MAIL PADDLE STEAMSHIP ARABIA. BUILT 1852.



STEAMSHIP PERUVIAN.



ALASKA (GUION LINE).



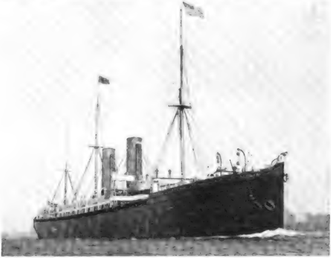
CUNARD ROYAL MAIL PADDLE STEAMSHIP PERSIA.
3,300 tons. 3,600 I. H. P., with accommodations for 250 cabin passengers. Built 1856.

men urging that, because steamers could not carry coal sufficient for long distances, and because the expense of maintenance made any remuneration impossible, therefore long voyages should be made only by sailing ships. In these discussions the transatlantic route three thousand miles long was particularly considered. Not until the year 1838, when the Sirius, of 700 tons, and the Great Western, of 1,340 tons, steamed into New York harbor from England, was the practicability of navigating the ocean by steam alone triumphantly established.

It is not intended to give many details of particular ships. Some,

CUNARD ROYAL MAIL STEAMSHIP RUSSIA.
35 ft x 43 ft. x 27 $\frac{8}{10}$ ft. 2,960 tons 2,800 I. H. P. Speed 13 knots. Built in 1867 on the Clyde. Lost on the coast of New Jersey.

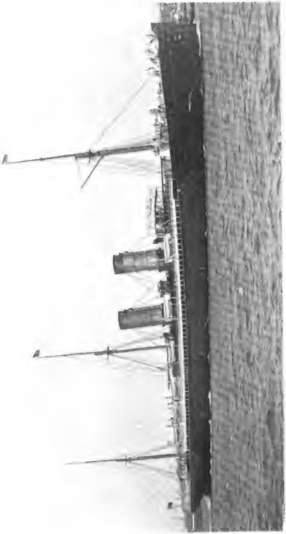
however, are needed to illustrate with distinctness the progress made in the evolution of the steamship. Thus the advent of the Great Western was an event of importance in deep-sea steaming, because she was the first vessel constructed especially for a long sea-voyage. In size she greatly exceeded anything built up to her time, being 236 feet long, 35 feet broad, and 17 feet draft. Her engines were of the side-lever type, with two 74-inch cylinders and a piston stroke of seven feet, which drove her paddle-wheels at the rate of twelve revolutions a minute. There were four iron rectangular flue boilers, supplying steam of eight pounds' pressure to the square inch; the coal consumption was about 75 tons a day; the h. p. was 750, and the speed was 8.2 knots.



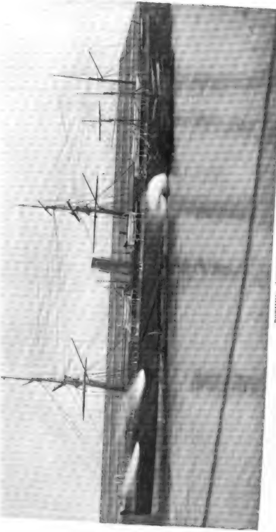
SERVIA.

The permanent setting in of the tide of progress in the building and designing of ocean steamships began with 1840. From that beginning, only fifty-seven years ago—easily within the memory of many a man now among us—there has been an advancing, sometimes rapid, sometimes sluggish, towards the present mark. Now the tide is at a stand, but it will doubtless be flowing again in a short time.

In 1840 was organized the famous Cunard steamship company for the purpose of conducting trade and carrying the mails at regular intervals between Great Britain and the United States. Four wooden



UMBRIA.



BOTHNIA (CUNARD LINE).

paddle-wheel steamships, the very best that man's ingenuity could devise, were put into service. The dimensions of the Britannia, the first one, were: length, 207 feet; beam, 35 feet; draft, 17 feet; tonnage, 1,154 register. She had side-lever engines, with two 73-inch cylinders and a stroke of seven feet; there were four rectangular boilers and twelve furnaces; the steam pressure was 9 pounds per square inch; the i. h. p. was 740, the speed 8.5 knots, and the coal consumption 38 tons a day.

The success attending this venture of the Cunard company stimulated other organizations. Presently a line of steamers was started for Mediterranean ports, and soon afterwards lines were in operation reaching to every quarter of the globe. The steamship itself was thus brought into prominence, and its improvement enlisted the efforts of many men of scientific attainments. Already the unsuitableness of the paddle-wheel had been discerned, the chief practical difficulty being connected with the constant changes in the immersion of the floats. In long voyages the consumption of coal and stores lessened the draft of the vessel considerably; hence, wheels effective at the beginning of the passage, would be much less so at the end. Further, the rolling of the ship at sea affected the action of the wheels; at one moment a wheel would be completely submerged, and

AUGUSTA VICTORIA.

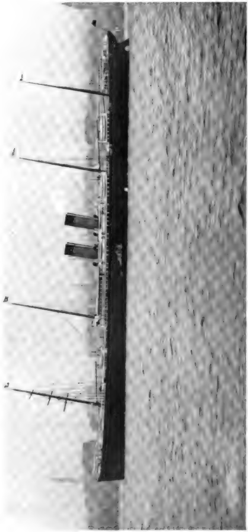
the next be altogether out of the water, causing the engines to race violently and endangering the machinery. To obviate these difficulties the screw propeller was introduced.

Some time before this, the screw propeller had been invented and tried. In 1836 Ericsson put it to the test, and in 1838 he fitted it to a small iron boat 70 feet long. Here a new material of construction and a new method of propulsion were introduced together; a still further innovation, in the Stockton, was a direct-acting engine, with 16 inch cylinders and 18-inch stroke. This ship, which sailed across the Atlantic to the United States, was the first propeller in our waters. Ericsson followed her.

The crowning effort of this epoch, and at the same time a most daring leap into the future, was the launching in 1843 of the steamship Great Britain, designed by Brunel, the genius who afterwards designed the Great Eastern. The Great Britain justly ranks as the most astonishing achievement of the day in marine engineering. Up to the time of the Great Britain's exploitation and for a great many years afterwards, steamships were built of wood, and were propelled by paddle-wheels; but the Great Britain was built of iron and was propelled by a screw. Although she was not the first ship in the world to be so constructed and so engined, yet she was the first of her kind designed for deep-water cruising. Properly speaking, the Great Britain was the prototype of the modern steamship of steel with twin screws. Her dimensions were: length, 322 feet; beam, 51 feet; draft, 17 feet; tonnage, 3.400, register. Her engines were of the geared pattern, with chains wound on drums, instead of toothed wheels; one turn of the engine gave three turns to the screw. There were four cylinders, 88 inches in diameter and with a stroke of six feet; the screw was six-bladed, 15.5 feet in diameter and 25 feet in pitch; the coal consumption was 70 tons a day; the speed was a fraction over eight knots.

The nautical world condemned the principles involved in the construction and machinery of the Great Britain; her engines, her material, her large coal-consumption, her limited bunker capacity, her speed, the expense of her maintenance and the costliness of her designs, deterred further experiments on the same lines. Instead, marine engineers devoted their talents to perfecting wooden steamships and paddle-wheels. Screw propulsion, however, attracted the serious attention of several naval authorities; in 1843 the French government fitted a frigate with an Ericsson screw, driven by direct-acting, horizontal engines, placed below the water-line of the vessel—the first machinery of the kind ever put afloat. In 1845 the English navy tried for the first time a propeller with blades of varying pitch.

OCEANIC. 3,707 TONS. 3,500 I. H. P. BUILT 1870.

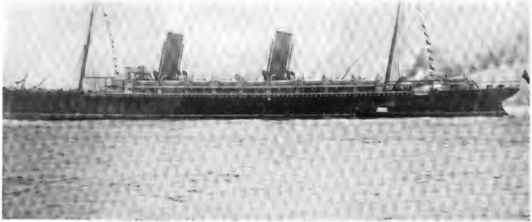


BRITANNIC. 5,000 TONS. 5,000 I. H. P. BUILT 1874.

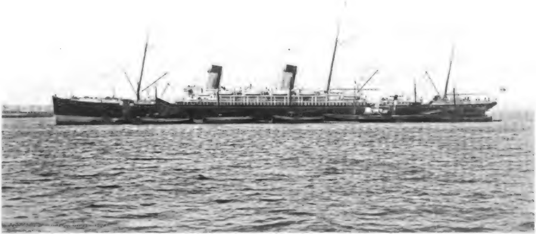
Perhaps more progress was made in screw propulsion and in improving the models of ships, by the United States than by any other country. At that time the government launched the man of war Princeton, of 1,000 tons. The machinery was designed by Ericsson, and his genius was discernible in many other strange features of this novel craft. The engines had double or compound semi-cylinders of different diameters, with double pistons placed in opposite directions, both being acted upon by the steam at the same time, their differential force being the effective motive power of the engine. The diameters of the semi-cylinders were 20 inches and 72 inches; the stroke was 96 inches, and the nominal h. p. 250. There were three iron rectangular boilers with semi-circular tops. Another innovation in the Princeton was a telescopic smoke-stack. The propeller had a cast-brass hub, with six blades 14.5 feet in diameter, and 32 feet in pitch. The performance of this extraordinary machinery, when operated under a steam pressure of 12 pounds per square inch and burning 1,300 pounds of coal an hour, was a speed of 6.3 knots. In 1847 the Princeton was fitted with return drop circular flue boilers; the same pressure resulted and the same speed. The revolutions of the screw were 25 a minute.

The model of the Princeton was peculiar. She had a very flat floor amidships, with great sharpness forward and excessive leanness aft. The run was remarkably fine. Lindsay, in his "History of Merchant Shipping," states that, in thus departing from the style of round or bluff bows and full sterns previously prevailing, and substituting a fine entrance and a clean run, American naval architects were the first to improve the form of steam vessels. By these important alterations and by subsequently making the length of merchant steamers at least eight times the beam, ship-designers succeeded, even during the infancy of marine steam propulsion, in raising the speed from nine to thirteen knots, and in giving to the world lines for the modeling of ships vastly superior to any hitherto adopted.

The steam history of the decade following is quite as wonderful. At the very commencement many new ocean-going steamers were put afloat, in which were embodied in substantial form nearly every conspicuous feature hitherto essayed experimentally. The improvements in model, in motive power, and in habitability which particularize this era can be attributed primarily to the influence of the intense rivalry among different steamship companies in their efforts to gain the control of the rapidly-increasing and remunerative Atlantic trade. Ships built of wood were matched against ships built of iron; paddle-wheels were in the running against screw propellers; and long, narrow, deep hulls were pitted against short, chunky, broad ones.



CAMPANIA.



MAJESTIC (WHITE STAR LINE).

To three well-known steamship companies should be given the credit for thus materially furthering the cause of steam navigation: first, to the Inman company, for boldly and with rare foresight placing in commission a fleet of large sea-going, iron steamers, propelled by a screw: second, to the American Collins line, for superiority of model, internal arrangements, and fine machinery; and, third, to the Cunard line, for excellence of construction and general efficiency. The point of radical difference between the American and Cunard ships lay in the boilers of the former, which were arranged with double furnaces and lower water spaces connected by a row of vertical tubes around which the heated gases circulated.

As ship followed ship in those days, so did improvement follow improvement, each vessel, no matter by whom put afloat, possessing certain characteristics which made her a better sea-boat than her predecessor. How great this onward movement was, and how thereby the steamship was benefited, can be best understood by stating some facts pertaining to two famous ships,—the Britannia, of 1,150 tons, built in 1840 of wood, and the Persia, of 3,870 tons, built in 1856, of iron. The former consumed in a voyage 570 tons, the latter 1,400 tons, but the cargo capacity of the Persia was 750 tons to the Britannia's 224 tons. The Persia was the largest steamer in capacity of hull and steam power that had ever been built. For two and a half times the quantity of coal, she carried nearly three and a half times the quantity of cargo, "which can be attributed to increased engine efficiency as well as to increased size of hull." Both ships had jet condensers and simple side-lever engines, but the boilers of the Britannia were of the flue type developing 9 pounds of steam, while those of the Persia were of the tubular pattern developing 30 pounds. The speed of the former was 8.5 knots; of the latter, 13 knots. The refinement of the lines of the hull of the Persia should also be noticed, one of the primary conditions of high speed being fineness of form; the length of the Persia, more than eight times her beam, indicates that she was modelled with a fine entrance and a clean run; the Britannia was but 6.4 times as long as she was broad.

But the crowning effort of the time was the launching in 1856 of the Great Eastern, built for the East Indian trade. She was of gigantic size, unequalled even to-day by any ship afloat, and in other ways she was remarkable, many distinguishing traits of the modern steamship appearing first in her. She was divided interiorly into several water-tight compartments; from keel to water-line there was a second hull, three feet inside the outer one,—the double bottoms of to-day,—and the method of bracing and securing the huge structure was the cellular system. In the light of our present knowledge of

naval architecture, the Great Eastern exhibited in herself the most astonishing progress. Unfortunately the propelling machinery and coal capacity were inadequate and far behind the other features in development.

Most naval constructors at this time were perfecting what had thus far been experimentally successful. After 1860 iron gradually took the place of wood as a ship-building material: surface condensation was substituted for jet condensation; and the screw was adopted as better than the paddle-wheel. The engines in use while these improvements were maturing were only variations of those used twenty years before; the side-lever, the geared, the oscillating and the direct-acting were the types most common; they were all fitted with jet condensers, consumed from four to five pounds of coal per hour per h. p., and worked with pressures of about 25 pounds. The advantages following the adoption of surface condensation, permitting fresh water to be fed to the boilers and thus minimizing the loss of steam by blowing off, were a diminution of coal consumption to about three and a half pounds, and a raising of the steam pressure to about 40 pounds.

A still better move in economy and efficiency was the introduction of the compound principle, working steam at a high pressure in one cylinder and afterwards at a low pressure in another cylinder. There was nothing new in this principle, but its application to marine engines was novel. The Pacific Navigation Company of England was the first to try compound engines, fitting them in two vessels, the Valparaiso and Inca, in 1856; the cylinders were two high-pressure of 50 inches and two low-pressure of 90 inches. As the old boilers and jet condensers were left in the ships, the working pressures of steam were only 25 pounds; but, despite these drawbacks, the engines were considered satisfactory, though the maritime community at large refused to accept the type until better steam generators were made. From which it seems that the elaboration of the compound engine depended on improved boilers. These came along shortly, after 1860, followed by a corresponding betterment in marine engines. There was thus effected a saving of fuel, the consumption per hour per h. p. when the engines were compounded being about two and a half pounds: subsequently this was reduced to 2.11 pounds.

With increased steam power there also came increased size of hull, care being taken not to repeat the mistake made by Brunel in the Great Eastern, of providing inadequate machinery. In the tonnage launched in the seventies greater size of hull is as conspicuous a feature as greater power of engine: another point to observe is the refinement of the lines of these large hulls. The advent of the White Star line in 1870 was the opening event of importance of this era, that

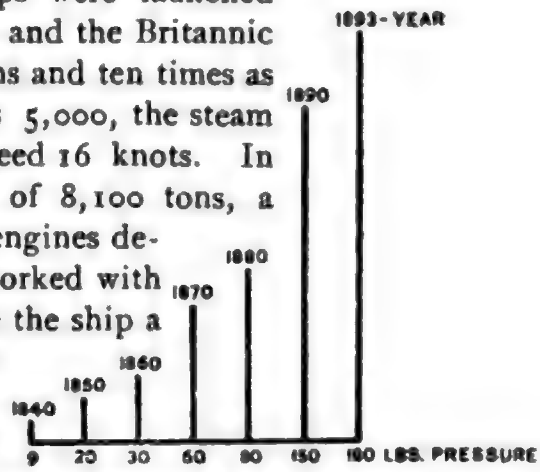
company placing in service a model class of ship. The Oceanic, the initial vessel of the fleet, had the lines and symmetry of a yacht, and such superior internal arrangements, that they have been substantially adhered to in all steamships since laid down. This Oceanic, of 3,700 tons and 420 feet long, has, after a quarter of a century of work well done, been retired to make way for a new Oceanic 704 feet long,—25 feet longer than the Great Eastern; in depth and size the new leviathan and the old will be about the same. It was predicted, when Brunel's great ship proved so signal a failure, that never again would such a monster be attempted, and that thereafter large steamers would more nearly approach 500 feet than 700 feet. Just forty years have passed since the advent of the Great Eastern, and present developments warrant this new prediction,—that all ocean steamers, whether for freight or for passengers, will hereafter more nearly approach 700 feet than 500 feet.

To return to the seventies. It is remarkable to note the extraordinary progress achieved even in the short time since the Britannic made her first voyage in 1840. Though measuring 1,140 tons, she had a capacity for only 225 tons of cargo, whereas the Bothnia, of 4,335 tons, built in 1874,—for her day a model screw ship, with all the improvements then known to ship-designers,—carried about 3,000 tons of cargo, nearly 14 times as much, though herself only about four times larger. The Britannic steamed 8.25 knots, the Bothnia 13 knots; and the latter steamship did all this extra work on less than half the quantity of coal per h. p. per hour, and on about the same quantity for the actual number of miles run. In other words, the engines of 507 nominal h. p. in 1874 drove a vessel of 4,335 tons at a speed nearly twice as great as that at which engines of 425 nominal h. p. drove a vessel of only 1,140 tons in 1840, and with not half the consumption of coal.

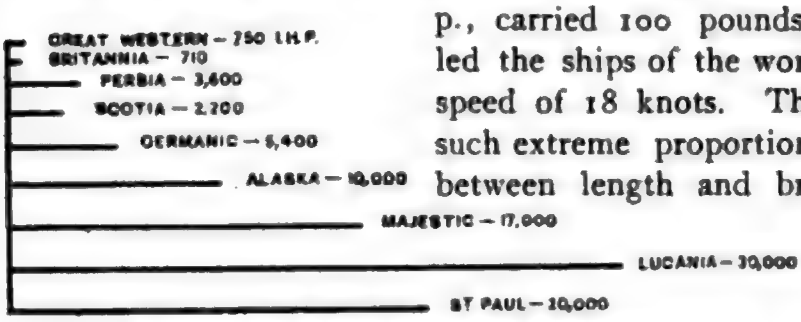
Compound engines were generally fitted after 1870, with surface condensers, tubular boilers and propellers. In the making and designing of this machinery there were many improvements whereby the rate of consumption of coal was reduced and the weight of the engines and boilers was lessened; pressures, as a consequence, increased, and so, too, the speed of the pistons. Soon the receiver type of compound engine was put in service; and, when the steel boiler with corrugated flue was introduced, it became very efficient. With the best iron boilers the pressures could be maintained at 60 pounds, without unduly sacrificing weight of boiler to safety, but with the steel boiler the great strength of the metal permitted not only the use of less thickness, but also the safe carrying of steam at much higher pressures. Ninety pounds was raised with confidence, with the result

that there was a decrease in the consumption of fuel from 2.11 pounds in 1871 to 1.9 in 1881; there was a like acceleration of piston speed,—from 366 feet a second to 466 feet a second.

Several world-renowned ships were launched during this epoch; the Germanic and the Britannic were two of them, of 5,000 tons and ten times as long as broad; the i. h. p. was 5,000, the steam pressure 60 pounds, and the speed 16 knots. In 1881 came the City of Rome, of 8,100 tons, a leviathan for those times; her engines developed nearly 12,000 i. h. p., worked with ninety pounds of steam, and gave the ship a speed of 18 knots. At this time also appeared the Alaska, of 7,000 tons, the first so-called "greyhound" of the pack that have since been coursing across the Atlantic. She was 500 feet long and fifty broad, of 10,000 h. p., carried 100 pounds of steam, and led the ships of the world with her sea-speed of 18 knots. The advisability of such extreme proportions as ten to one between length and breadth was after this somewhat modified, quite as good results following. Shorter ships are handier, have greater stability, and stow more cargo.



INCREASE OF STEAM PRESSURE IN 50 YEARS.

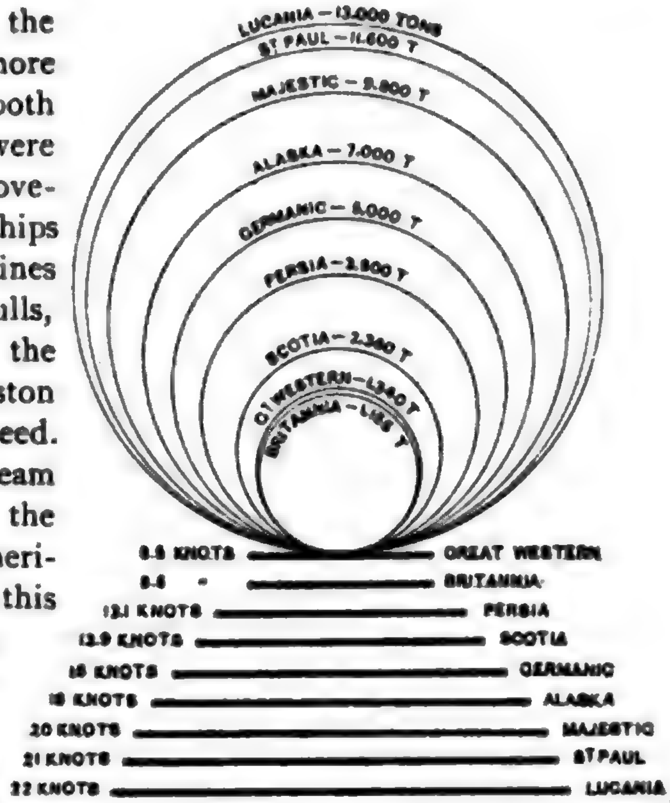


INCREASE OF HORSE POWER IN 50 YEARS.

From the compound engine to the triple-expansion engine was a natural step. It had been attempted in 1874 in the English steamer Propontis, but had proved abortive because of inadequate boiler pressure. The steel boiler and attendant improvements in steam-generating made triple-expansion a success; one hundred and fifty pounds of steam were demanded, and this demand was easily met. Statistics collected from a number of ocean steamers show that the average consumption of coal when the engines were simply compounded was, as above stated, 2.11 pounds, with boiler pressures of 45 to 60 pounds; in the receiver type the consumption was reduced to 1.9 pounds, and the steam pressures rose to 90 pounds; in the triple-expansion type the pressure rose to 150 pounds, and the amount of coal consumed was reduced 18 per cent.

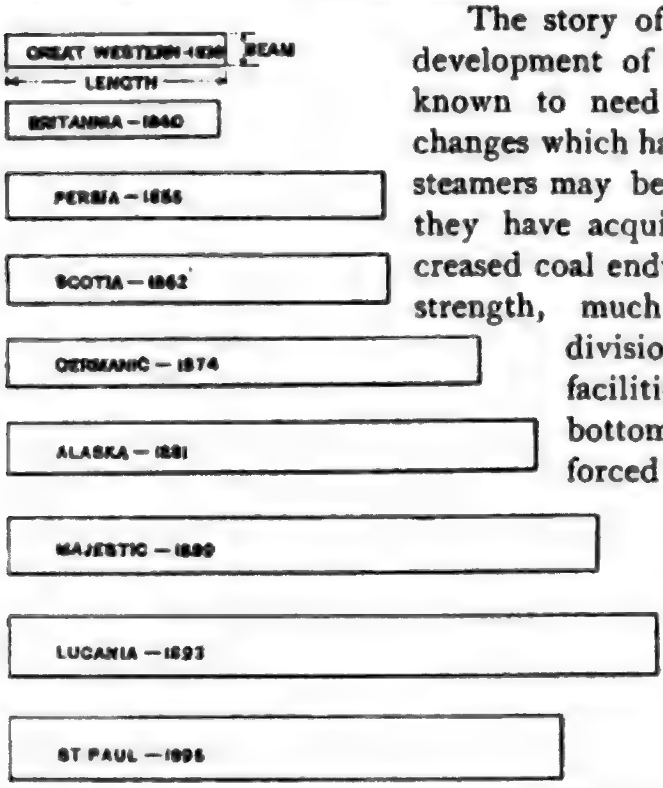
Mild steel as a ship-building material was first employed in 1880 in the Buenos Ayrean of the Allan line. It was not tried before this,

because of its expense; the more it cheapened, the more it was used. Presently both ship and machinery were constructed of it. Improvements followed, in both ships and machinery. Better lines were observed in the hulls, more powerful grew the engines, faster the piston strokes, and higher the speed. Soon 180 pounds of steam were carried. Finally the Inman line, now the American, decided to utilize this vast power by working it off in two screws instead of one. Ten years ago, therefore, the Paris, the pioneer twin-screw merchant steamship of the world, made her appearance.



COMPARATIVE TONNAGE AND SPEEDS.

The story of what has followed in the development of the steamship is too well known to need repeating. To-day the changes which have occurred in merchant steamers may be summarized as follows: they have acquired increased speed, increased coal endurance, greater structural strength, much better water-tight subdivision, improved pumping facilities, greater beam, double bottoms, steam-steering gear, forced draft and twin screws. Some of the changes were brought about largely as the natural development of the merchant trade. In part they have been due to special effort. All have improved the commercial value of the ships themselves.



INCREASE OF LENGTH AND BEAM OF STEAMSHIPS IN 50 YEARS.

MINE ACCOUNTS.

By J. Parke Channing.

A SYSTEM of accounts at the mine should show accurately the various items of expenditure entering into the cost of the unit of production, be that the ounce of silver or gold, the pound of copper, lead, or zinc, or the ton of iron ore or coal.

To the investor or the capitalist the total cost is the main point of interest; to the manager of the work the itemized divisions of this total cost should be of paramount importance. From them he is enabled to see the varying effects of different methods of operation, of new apparatus, and of different classes of labor. He is enabled to compare the cost during each month with that during preceding months, or with corresponding costs in other mines under similar conditions. Accounts should be so differentiated that the effect of every condition entering into the cost of production may be calculated in dollars and cents. Money may be expended for labor and for supplies. It is necessary, therefore, that the labor classification and the record of supplies used should be amplified to the utmost.

Time may be kept by foremen, or by timekeepers, or by both. It is generally preferable to have the foremen do this work; besides being more accurate, it compels them to keep closer run of their men. In case the number of men under one foreman are numerous, he may have the timekeeper as his assistant. In addition to turning in at the office each employee's name with the number of shifts worked and the rate per shift, there should be a daily report of the men employed, giving the number at each rate of wages at each particular class of work. At the end of the month the summation of these daily reports should equal the summation of the pay-roll sheets, always in days and usually in money, unless there be contract labor whose rate per day cannot be determined till the end of the month. Avoid the return of "Laborers" at the end of the sheet; a laborer must be doing something, and it is better to state exactly what he is doing, and allow the manager or the chief clerk to determine where his time shall be charged.

Where the property is large and there are foundries, machine, carpenter, boiler, and blacksmith shops, the time of the men should be charged by the hour and at the actual rate against the particular piece of work on which they are engaged. Pro-rating these shop charges of time leads to very inaccurate results.

The three steps in recording time are: first, the time sheets;

second, the labor-classification book, in which the time is distributed against the various accounts; third, the pay-roll, where the time of each man is drawn together, and his debits and credits recorded.

In charging supplies, the best practice seems to be to charge everything as it comes in to a supply account, or one of several different supply accounts, and, as the material is used, to credit supply account and charge to the correct operating expense. The advantage derived from this procedure is that it makes the treatment of material uniform, and the checking of requisitions, invoices, and bills of lading and the charging out follow the same lines, be the article a keg of nails, which may be eventually charged to one of a dozen different expenses, or a new hoisting engine, which can go only to equipment.

Freight on supplies, together with the local cost of handling and distribution, is charged against the supply accounts, and fixes the price at which articles shall be charged against the expense accounts. Fictitious profits on supplies or profits from shops should be avoided, as they simply tend to incorrect divisions of the total cost. There is nothing in this restriction to prohibit the charging of powder to contract miners at a high price, but, when this powder is charged in the cost sheet, it must be at the cost price plus the cost of handling and wastage.

All expenses may be divided under the three heads of construction, maintenance, and operating expense, and, as has been indicated, labor and supplies are the two classes of items entering into each. The question of a capital account in mining operations is one of extreme delicacy. From the very nature of its operation, a mine grows intrinsically less valuable each day, on account of the removal of some of its ore. Its marketable price may increase, however, if development is going on more rapidly than exploitation; yet, as ore does not grow in old stopes, the property is really of less value from day to day. Differing, therefore, from a farm, a railroad, or a cotton mill, a mine has a certain period of existence after which, with all its equipment, it becomes practically valueless. With but few exceptions it is impossible at the beginning to foretell the length of this period. In the case of some coal mines and of the horizontal iron-ore deposits of the Mesabi range in Minnesota, preliminary drilling may give a very close approximation of the total number of tons of mineral available, and this, divided by the proposed yearly product, will give the life of the mine. The uncertainty of the duration of this period suggests that the capital account be sunk as soon as possible, so that the books may be placed on a conservative footing.

There is no doubt that construction expense should be kept separate from maintenance and operating expenses. Its final entry as an item in the cost of production may be either by a yearly percentage charge from construction account, or by a direct entry each month, construction being considered as one of the operating expenses. The latter way is the safer, and is adopted by one of the largest copper mines in this country.

There is a tendency among subordinates, which is not always absent even from the manager, to make construction the dumping-place for many items that should go to maintenance or operating. This should be closely guarded against; nothing should be charged against construction which, in the nature of things, is really a repair or a renewal.

It perhaps is an error that in most mine accounts there is no distinct division between maintenance and operating expenses. As a rule, the maintenance of a hoisting engine or of a stamp mill goes in with the operating expenses, the whole being turned in as hoisting or stamping. There is no valid objection to this, if these expense accounts are sufficiently amplified to show all details.

While the total number of expense accounts which may with propriety be kept is indeterminate except with reference to a particular case, the following list will serve to indicate the principal final divisions of cost: (1) Exploration; (2) Construction; (3) Sinking; (4) Drifting; (5) Raising; (6) Stoping; (7) Timbering; (8) Tramming; (9) Hoisting; (10) Pumping; (11*a*) Stocking; (11*b*) Rock-House Treatment; (12) Loading; (13) General Surface Expense; (14) Railroad Transportation; (15) Stamping or Milling; (16) Office; (17) Superintendence; (18) Insurance and Taxes. There will be many more accounts, which will be charged or closed out monthly into the representative expense accounts.

Exploration will be charged with the preliminary work on the property, such as pits, trenches, drill holes, prospect tunnels, or shafts. As soon as the mine is shown to be of value, these charges should cease, unless outlying work of a similar nature or underground drilling is to be carried on.

When the mine proper is started, construction will be the first account of importance. As its name indicates, it will cover the cost of all buildings, roads, foundations, and machinery. It is here that care should be taken to prevent lumping. There should be a separate account for every building, every foundation, every piece of grading, and every machine, or class of machine. Do not put up a 100-stamp mill and charge everything, from castings to bricks, into a mill

machinery account. The time will surely come when you will want to know the cost of some particular class of work.

To sinking should be charged all the costs connected with putting down the shafts and getting them in shape to receive the cages or skips. It will include the labor and supplies used in blasting the ground, hoisting the dirt, timbering the shaft, and putting in the guides or rails, ladders, etc. The cost of cutting and timbering the stations at the various levels should be kept separately, but the amount may finally be charged in to sinking or drifting, as one sees fit. The unit of work for this division will be the foot of shaft sunk and completed for use. In addition to this, however, the cost of sinking per pound or ton of product should be calculated.

In making up the account of drifting, which is the operation of driving the levels from the shaft, it is not usual to include the cost of handling the broken material. As a rule, that goes into the cost of tramming; sometimes, however, when drifts are let on a contract and the miners tram their own dirt to the shaft, it is difficult to separate the two items.

Raising as well as Winze Sinking are figured out on the basis of the number of feet raised or sunk, as well as the ratio of their cost to the product.

Stoping includes the cost of drilling and blasting down the ore, so that it is in position to be loaded in cars and carried out. To arrive at the true cost of stoping, the number of tons actually stoped should be used as a divisor,—not the number of tons hoisted. It may be that a large part of the ore, coming from the drifts, should not be credited to the stoping.

In some mines it is customary to make a division of sinking, drifting, raising, winzes, and stoping into the two general classes of Opening and Breaking. Opening then includes the cost of shafts and drifts up to the point where ore is encountered. As soon as the drifts get into ore and are making a product, their cost goes in with stoping under the general head of Breaking. The following example will indicate the results of an incorrect divisor. Let us assume that our mine is in such condition that we have no sinking or rock work to do in a certain month, and that we produce 22,000 tons of ore, of which 2,000 tons come from 500 feet of drifts, and the balance from regular stoping. In the ordinary way the cost-sheet summary might appear in part as shown below.

In reality, however, the \$1,000 paid for drifting produced 2,000 tons of ore, which cost \$ .50 per ton, and the \$5,000 paid for stoping produced only 20,000 tons at a cost of \$ .25 a ton, and not \$ .227, as the cost sheet would lead us to infer. The actual average

cost of breaking the 22,000 tons of ore under the condition of the month is $ .272. The necessity of having these figures correct when one is to make estimates of future cost under given conditions is evident.

COST OF MINING 22,000 TONS ORE, SEPTEMBER, 1897.

Account.	Expense.	Cost per Ton.
Sinking............		
Drifting............	........$1000.00........	..........$ .045..........
Stoping............	.... 5000.00........	.... .227..........

Timbering includes the cost of the timber, its preparation, and its putting in place. Shaft timbering should be charged to sinking. Tramming is the cost of loading the broken ore or rocks into cars, and transporting it to the shafts. The cost per ton should be based on the total number of tons handled, be it rock or waste. Allowance should be made for timber handled. Hoisting is to be calculated on the number of tons of material actually hoisted. Pumping should be figured on the basis of million gallons; also the ratio of its cost to the finished product. In case the ore has to be put on stock pile, the expense of top men is charged to Stocking Ore. In case it runs through crushers and screens, these men would be charged, along with crusher men, to Rock-House Expense. Where the ore is run immediately into railroad cars, this expense comes under the head of Loading. Where ore has to be stocked, and then loaded at a later time in the year, Loading may be an important account. In most mines loading ends the handling of the ore, but, in cases where the company owns its own rail or tram road to the mill, Railway Transportation comes in. If ore is carried one way and fuel and supplies the other, an up-freight on the fuel and supplies equal to cost should be charged to them and credited to transportation, so that the balance of expense may represent the cost of handling the ore. Stamping or Milling should be based upon the material actually run through the mill. General Surface Expense, as its name indicates, covers necessary expenses on the surface of a mine, such as cleaning up, taking care of buildings, etc. Office involves expense of clerks, stationery, telegrams, etc. Superintendence may appear as an account by itself, or it may be charged into the various representative accounts. It seems preferable to have it include only general officers of the mine, and to charge foremen's time directly to their department. A better-looking cost sheet is made if Insurance and Taxes are charged each month,—one twelfth of the total,—than if they are put in as a lump sum once a year.

Each boiler house should have a separate account, to which should be charged firemen, water, fuel, and repairs. This is charged, in proportion to the steam used, to hoisting, pumping, compressing, etc. If an engine does both hoisting and compressing, then there should be a separate account for it, so that its expense may be properly divided. The cost of producing compressed air should be kept to itself, and charged to air drills, hoisting, and pumping, as the case may be. An air-drill account should be kept, and the total cost of air-drill repairs and sharpening charged to sinking, drifting, stoping, etc., on the basis of drill days.

At the end of the month a cost sheet should be made out from the data furnished in the regular books. This may be either a single large sheet, or a book of numerous small pages. While the large sheet does very well for a general *résumé*, it is undeniable that, when the work is of any magnitude, the book is much more satisfactory. Here each page can be devoted to some particular division of the work, and all the details and results given. Fig. 1 is a copy of one of the sheets used at a certain Lake Superior iron mine; while it may be open to criticism in minor details, it is, on the whole, very good.

In case there is a regular reduction of tonnage because of discarding waste material, the method of ratios produces good results. Suppose at a mine 10,000 tons of vein is mined to produce 3,000 tons of ore, and that this 3,000 tons, if concentrated by water, will produce 1,000 tons of concentrates, and that this 1,000 tons, if smelted, will produce 100 tons ot matte, which is shipped. Assume that it costs $3 to mine, $1 to concentrate, and $4 to smelt, and that, although only 9,500 tons of vein were mined for the month, 1,100 tons of concentrates were smelted, the stock being drawn upon. What did the matte cost per ton? We have the following ratios: ore to vein material, 30 per cent.; concentrates to ore, 33⅓ per cent.; matte to concentrates, 10 per cent.

COST OF PRODUCING MATTE, SEPTEMBER, 1897.

	Amount.	Per ton of Matte.
Mining 11,000 T's vein....................at $3..	$33000.00	$300.00
Concentrating 3,300 T's ore................at $1..	3300.00	30.00
Smelting 1,100 T's concentrates............at $4..	4400.00	40.00
Coat of producing 110 tons Matte..............	$40700.00	
Cost of producing 1 ton Matte.................		$370.00

Had the actual total mining cost for the month been used, 9,500 tons at $3.00 per ton, $28,500, it would have shown a fictitious lower

....................IRON MINING COMPANY.

Statement showing Cost of Producing...........Tons of Ore during........18....and for Producing..........Tons from........189..to........189..

EXPENSE ACCOUNTS.	For........Month.			For Previous M'ths			For........Months		
	Expenses.		Cost per ton	Expenses.		Cost per ton	Expenses.		Cost per ton
	Labor	Supplies		Labor	Supplies		Labor	Supplies	
MINING EXPENSE.									
201 Opening									
202 Stoping									
203 Timbering									
204 Tramming									
205 Cage and Skip Tenders									
206 Pumping									
207 Compressor and Air Drills									
208 Underground Tracks									
209 Mining Captains									
210 Shift Bosses & Timekeepers									
211 Gen'l Underground Exp'se									
212 Hoisting Expense									
213 Diamond Drilling									
214 Picking and Sorting Rock									
SURFACE EXPENSE.									
301 Stocking and Sorting Ore									
302 Shipping Ore									
303 Warehouse									
304 Office									
305 Surveying and Chemistry									
306 Electric Light									
307 Air Fund Contribution									
308 General Repairs									
309 General Surface Expense									
310 Miscellaneous									
GENERAL EXPENSE.									
Taxes									
Insurance									
TOTAL COST for Month & Year									
COST PER TON " " "									
Add to reduce Equipment Acc't									
Total Cost per Ton									

PRODUCTION STATEMENT.

SHAFTS	Tons of Ore Mined.		
	For Month	Prev Months	For Months
Production Mining			
Tally			
Add Overrun			
Total Production			
Shipments			
Balance in Stock, 189			

SUMMARY OF SUPPLIES USED.

Classification of Supplies.	Cost of Supplies		Tons Ore Mined.		Cost per Ton.	
	Month	Year	Month	Year	Month	Year
101 Explosives						
102 Candles						
103 Oils						
104 Drill Steel						
105 Iron and Steel						
106 Lumber						
107 Mining Timber						
108 Tools						
109 Steam Packing						
110 Gas Pipe&Fittings						
111 Carbons						
112 Fuel						
113 Miscellaneous						
Totals						

AVERAGE OF ALL LABOR.

	Rate Per Day.
Contract Miners	
" Trammers	
" Timber Cutters	
Average Company Account	
General Average of all Labor	

matte cost, and certainly a higher one the succeeding month, should stocks have been increased during that period. In cases where the reduction is small, as from 100,000 tons mined to 95,000 tons hoisted to 90,000 milled, the mistake is often made of adding the individual costs per ton to get the total cost, without introducing the proper ratios as multipliers.

There is another class of record which should be kept in every mine, as well as in every industrial establishment,—a record of Work Per Man Per Day. This record tells far better than a cost sheet whether the men are doing good work, as the effect of varying wages is eliminated. How many feet a day does a man sink in a shaft, how many tons does he break in a stope, how many ton-miles does he tram in a day,—these are questions of vital importance. A convenient form for this sheet is as follows:

SUMMARY OF LABOR SHEETS.

	Tons.	Feet.	Days.	Amount.	Wage.	Per man per day		Labor cost per	
						Tons.	Feet.	Ton.	Foot.
Sinking.....									
Drifting.....									
Raising.....									
Winzes.....									
Stoping.....									
Tramming.									
Landing....									

One very interesting figure is the number of tons of ore mined per day, divided by the total number of shifts worked during that day, from the manager down to the drill boys.

Each mine is different from every other mine, and, as no two mines can be wrought on the same system, so no system of bookkeeping will do for all mines. Each manager must adopt a system for himself; the main idea of the present article is to suggest the use of a logical method by which the various steps of handling or treatment may be followed up and analyzed as they occur in actual practice.

THE ECONOMICAL PRODUCTION OF POWER IN SMALL UNITS.

By E. T. Adams.

THE past decade has not been without its notable triumphs in the field of steam engineering. It has been a period of advance along familiar paths rather than one of epoch-making changes; indeed, broadly speaking, all progress, in the United States at least, has been along lines clearly indicated by the pioneers of twenty or thirty years ago; but along these lines the advance is notable. The goal of all progress is economy, and in no direction has the advance made during the past decade been more marked. Builders of standard types of boilers daily guarantee an evaporation which a few years ago would have been considered exceptional or unattainable, and the certainty with which, under favorable conditions, this evaporation will be brought to within a few per cent. of the results which represent the maximum efficiency yet attained is a remarkable evidence of the advance in this branch of steam engineering. In durability, closeness of regulation, and smoothness of operation, all types of the steam engine have been brought to a marvelous degree of perfection, and with large engines of certain types, under favorable conditions, the steam-consumption per i. h. p. has become exceedingly small. Little by little the combined efficiency of the best types of engines and boilers has been increased, until at the present time, under favorable conditions, the consumption of fuel per i. h. p. has been reduced to a point beyond which comparatively little reduction can be hoped for from present types of engine and boiler, or, indeed, from any system in which steam is the heat-bearing medium. Hence the attempts to reduce the number of transformations of energy, and consequent losses, which occur between coal-pile and line-shaft by the elimination of both boiler and engine,—that is, the conversion of the potential energy of the coal, by a single trausformation, into electrical energy, as simply summoned and as ready for prodigous effort as the fabled genii of Aladdin. This is the modern dream of energy direct from coal.

This maximum efficiency, however, which has summoned dreams of a new and brighter era in the production of power, and which to some has seemed to indicate that we have now practically reached the limit of progress in the development of the steam engine, has, up to a recent period, been attained only in the larger plants, with engines of five hundred to one thousand horse power and upward, working under especially favorable conditions. Now the conditions commonly met

in practice are wholly different. The engines are usually comparatively small, and the conditions far from favorable to their economical operation. Probably not less than ninety per cent. of the steam power in use in stationary land service in this country is developed in small stations, in engines of less than two hundred horse power each, working under conditions far from favorable to economy. It is safe to say that the efficiency of a small steam plant working under usual conditions seldom reaches fifty per cent. of this maximum efficiency which has so fired the popular imagination, and in at least one very important class of cases this efficiency is probably not higher than twenty-five to thirty-five per cent. of that secured in large plants under favorable conditions. It would seem, then, that the epoch-making change next to come is not the production of energy direct from coal, but, rather, changes making greater economy possible under the conditions commonly met in practice,—that is, more economical production of power in small stations.

There are many indications that changes which will make this possible are now in progress, and, while the next century may or may not produce light without heat, or power from coal without the steam engine, it is reasonably certain that the closing years of this century will see an increase in efficiency of plants of this class which, while it may not bring them up to the present standard of maximum efficiency, will be wider-reaching than any changes since the days of Corliss. In order to see how this is possible, it is necessary to consider the distribution of the cost of power, and also to investigate the conditions which have controlled the development of engines of moderate size.

The distribution of the total cost of power is, for small stations, approximately as follows: fuel, 40 to 50 per cent.; attendance, 25 to 30 per cent.; interest, about 15 per cent.; supplies and repairs, about 15 per cent. In a large station the distribution of cost is much the same, except that the cost of attendance is a smaller, and the interest charge a larger, percentage of the total. It appears, then, that the reduction of the cost of power which has been effected in the large stations has been secured by making some saving in each item (interest only excepted), which enters into the cost of power; and, reasoning by analogy, it seems probable that, if any reduction of cost is possible in the small stations, it must be made in the same way—by saving a percentage of each item which goes to make up the total cost. Further, if the cost of power at the small station is to be cut in half,—as it must be if there is to be any epoch-making change in the present practice,—it is probable that each item entering into the total cost must also be cut in approximately that proportion.

Is any appreciable reduction in the cost of power possible when that power is developed in a small station under the conditions commonly met in practice? In discussing this question the boiler and its adjuncts will not be considered; a saving, often of considerable magnitude, is nearly always possible, but the question, so far as the boiler is concerned, is simply one of proper selection and management, while the engine is passing through a stage of development which seems certain to produce either a new type, or a modification of some existing type, which, by reason of better fitness for the conditions, will be a most important factor in determining the cost of power in small stations. Fuel is the largest item in the cost of power. The fuel-cost depends chiefly on two things; first, on the efficiency of the boiler and engine chosen; second, on the possibility of operating both continuously at the load at which this efficiency is greatest. If, as usually happens, this load is variable, the engine can be kept at or near its miximum efficiency by employing several small units which may be brought into action or shut down as the exigencies of the service demand. It is largely due to such expedients as this that the cost of power in the larger stations has been so greatly reduced; but, when the power developed is already small, any subdivision of power implies the use of a very small unit of power,—that is, the use of a very small engine. Now, that a small engine is an uneconomical engine is so commonly true that it is usually accepted as necessarily true; we shall see presently why this is an error, but for the present it is enough to note that the first step toward higher economy is the development of small engines which shall afford a much higher fuel-economy than is usually secured at the present time.

The second large item is attendance. This will always be a large item in any small power station, but even with the high-speed engines, which have won their way for this class of service in spite of their manifest defects, the cost of attendance can be very greatly reduced by skilful designing. When properly designed, a small engine should not require more in the way of attendance than the services of some one to stop or start it, with occasional, say weekly or monthly, skilled inspection. If it requires more than this, cost of attendance has not been sufficiently considered in design. For example, bearings of ample proportions for the load they are to carry may become wholly insufficient. Taking into account the cost of attendance and the allowable frequency of adjustment; and complication not at all objectionable in a large engine, where the cost of attendance becomes a minor item, is not to be thought of for the small engines we are now considering. There is no excuse for the use of a multiplicity of small sight-feed oil cups, or for the dozen or more unneces-

sary joints or parts in the valve gear. These things require constant skilled attention; and more thorough lubrication, better regulation, and better steam distribution can be secured by other and simpler means. The bearings of a small engine should not be a copy, in miniature, of the bearings of the engine of larger power. It is largely on account of such designing as this that an engine of one hundred horse power often demands more skilled attention than one developing ten times that power. The bearings of the small engine should be few and abnormally large; the smaller the engine, the less should be the adjustment required; in fact, the necessity for adjustment should, by proper designing, be made to vary, say, inversely as the square of the power developed. At the limit—that is, for engines of five or ten horse power—adjustment three or four times a year should be ample. What a boon such an engine would be, what a necessity such an engine is, to the busy farmer, for example! The small engine demands automatic and copious lubrication. This is best secured by using some oiling system such as that adopted by Westinghouse, Willans, or the Ideal engine companies, or by the system lately adopted, at the writer's suggestion, by the Payne Engine Company. Each of these systems has its individual "points," but all are cheap, require absolutely no attention, are very economical of oil, and furnish oil continuously and in abundance to every bearing in the engine. The saving in engine friction due to this system averages five per cent. of the rated horse power of the engine, while the cost of oil and supplies is generally reduced to about one-tenth of the usual amount. All these things tend toward greater simplicity, and this means less first cost, less interest, and less expense for repairs, as well as less cost of attendance. That is, increased simplicity effects a reduction in every item entering into the cost of power, except the fuel-cost.

Now, greater economy in the consumption of fuel, which, when we consider the engine only, means a better steam distribution, is usually secured by increased complexity of construction, but it is not necessarily secured in this way. A steam distribution closely approaching that of the Corliss type can be secured with the simplest possible type of valve and valve gear. Variable expansion may be secured, and the evils of early release and either excessive compression or excessive clearance can be wholly avoided; perhaps the details of the way in which this may be accomplished are somewhat beyond the scope of this paper, but I may say that the clearance is kept down by the methods so successfully employed by Professor Sweet, and that by this and other equally simple means the much-abused plain slide valve, with the simplest connection to a single eccentric,

can be made to give a steam distribution approaching closely to that secured at the expense of so much complication in the Corliss and other types of valve gear.

If it is accepted as true that simplicity should be the controlling element in the design of a small engine, the choice is at once limited to three broad classes of engines,—namely, throttling, automatic, and the variable expansion engines having positively-driven valve gear; in the United States that in most general use is the single valve automatic. Now, with this type of engine there is usually a loss greater even than that due to excessive clearance or defective steam distribution. This loss is due to leakage past the valve, and "leaky" rather than "single" valve automatic would often be the proper title to use in describing this engine. This excessive leakage, however, appears to be a comparatively recent development. It has resulted from the attempt to secure very close regulation when the governor, by reason of complicated construction or some other cause, was unable to give good regulation, unless the valve and valve gear were practically frictionless. It is difficult to prevent the common types of balanced valves from leaking, especially when high steam pressures are used, but it can be done, if the governor is not too sensitive. When any balanced valve fits its seat closely enough to prevent leakage, there is certain to be considerable friction, and, while the force required to overcome this friction and the inertia of the valve is not great, it is only within a recent period that governors have been designed which give regulation within one per cent., and at the same time are powerful enough to drive a valve fitted steam tight. Governors capable of accomplishing this are now used by a dozen or more prominent high-speed-engine builders. All, or practically all, of these are designed according to the Rites system of governing. The principal feature of this system is the balancing of the gravity action of a single weight by its inertia, which allows the use of a construction of great simplicity. There is usually only one piece and only one joint in this governor, and governors designed according to this system have given practically perfect regulation when driving a plain, unbalanced slide valve. This and the system—due to Professor Sweet—of reducing the clearance space, the use of steam-tight valves, and the simple, but effective, system of steam distribution adopted, may be mentioned as important features of the type of high-speed engine now in its formative state, which seems likely to bear much the same relation to the usual type of automatic engine that the Willans engine, coming so extensively into use in Europe, bears to its prototype, the throttling engine. In every respect, excepting possibly first cost, this Willans engine fulfils the requirements which we have es-

tablished ; but in the United States the prejudice against the throttling engine is very hard to combat, and, although the Willans engine has been on the American market for several years, it has, doubtless on this account, failed to secure the success it undoubtedly deserves. In England this engine has achieved a remarkable success, to which we may refer later as illustrating the effect of business conditions on engine design, and on the lines along which development takes place.

First cost is also important as determining the expense for interest and depreciation, but under present conditions, considering the fact that the engineer is seldom consulted in the purchase of small engines, first cost becomes the all-important factor ; and it is certain that a small engine, no matter how economical it may be in operation, will not have a chance to demonstrate its superiority, unless its first cost is less than that of the engine with which it must compete, and this again indicates that simplicity must be the controlling element in design.

In so far as the engine can affect the cost of power, it is certain that this cost will be greatly reduced, and it is probably entirely safe to predict that in the near future small stations equipped with small engines will, at constant load, generate power at a cost that would be considered an average figure in Corliss practice under the same conditions ; when the load is variable, the advantage will surely lie with the small engine. The engine, however, while it is an important element in determining the cost of power, is not the only one. There is a more important element affecting every item which enters into either the first cost or the cost of operation, and, indeed, with an influence reaching far back of this. and producing a marked effect on engine design. This is the general practice regarding the employment of a consulting engineer. For reasons which it is profitless to discuss, the usual practice is to erect the small steam plant without the aid of engineering advice other than that furnished *gratis* by the interested builders of the machinery installed. As an immediate consequence, the capacity of the plant is, in the majority of cases, considerably greater than is required. If this power were subdivided into a number of small units, a part could be worked at the best load for maximum efficiency, and the only loss would be the interest on the part standing idle ; but, with the engines usually installed, this is not possible, and in the majority of small plants the engine is underloaded practically all the time to an extent that renders any approach to economy out of the question.

Under competent engineering advice the selection of the proper type of engine for the service demanded is made a valuable aid in securing economy, but, in the absence of such advice, the type of engine

chosen simply indicates the buyer's prejudices or the salesman's ability, and it is an even chance whether or not it will prove the engine best suited for the particular conditions. This same remark applies with equal force not only to the boiler and its accessories, but also to every detail of the plant. And reaching beyond all this is the demoralizing effect on engine design when all engines are placed on one level by a buyer incapable of judging accurately the merits of each. This leads naturally and certainly toward the cheap and gaudy in design and finish, toward "high art" rather than "high economy," toward nickel plate and fancy trimmings rather than good engineering and substantial construction, and the highest efficiency will not be reached until the lessons of experience and the pressure hard times shall combine to bring about a more rational state of affairs.

Whether the owner of a small steam plant shall continue to be his own worst enemy, or whether he shall realize that there are some tasks which demand for their solution something more than purely business training, it is certain that some advance will be made, and that this advance will be due to the further improvement of the small engine. Even under present conditions we find able engineers maintaining that in large cities the small lighting station is destined to replace the large central station with its high ground rent and heavy transmission losses. And for street-railway service a small increase in efficiency will at once bring up the question whether two or more stations conveniently located along the line is not better than the one large station which must be located within a certain circumscribed area, regardless of convenience or cost.

These are isolated examples, without the field conceded to the small engine; and, given the engine, simple, compact, cheap, and economical, the prediction seems safe that its influence on steam-engineering practice will be wider-reaching than any change since the days of Corliss.

THE GOLD FIELDS OF KLONDIKE AND THE YUKON VALLEY.

By Harold B. Goodrich.

A YEAR ago it would have been difficult to find many to whom Alaska meant more than the northwest corner of the map of North America. A reminiscence of the events of thirty years ago might come with the mention of the word. "Alaska,—O yes, that worthless frozen country which we bought from Russia for two cents an acre." The Yukon then was only a name. But within the last two months has come an entire revolution in the attitude of our people toward the great northwestern territory. Who has not heard of the Chilkoot pass, St. Michael's, and, greatest watchword of all, Klondike with its treasures, the uncovering of which caused such an excitement in the middle of July? At that time we entered upon a gold madness which has not been equalled since the days of the Cariboo stampede in 1859. It is true that the latest discoveries are situated within British territory, but so near to our frontier that we are greatly affected, and even consider them our own. The public began to realize what some had known for a long time,—that there are great possibilities in that territory of which Uncle Sam has taken so little care. Immediately upon the announcement of the newly-discovered Eldorado, parties were fitted out all over the United States, east as well as west, and these parties attempted to enter the country by all the different routes, even when the approach of winter made such entrance dangerous, and, in the opinion of "old-timers," well-nigh impossible.

Some of these parties, unsuccessful in their efforts, turned back; others, having crossed the Chilkoot pass or ascended the Yukon, are well on their way to the diggings, whence news of their doings may transpire at long intervals during the next few months. In this mad rush are hundreds who have never had any experience in Alaska life; some are "tenderfeet," who think that gold is to be picked up everywhere, and will be much surprised to find that they are obliged to work even harder for a living than "on the outside." There will also be an influx of the blackleg element, those non-producers who live on the production of others, and are justly despised by the better class of Yukon miners.

Before this time the population was a little more than 1,700, but with this sudden increase the character of the interior must utterly

change, and it is probable that even now the civilization which the writer had occasion to observe last summer has become historic. Here these people have lived and worked,—a cosmopolitan community made up of representatives of almost all races and walks in life. They are mostly Americans; they are practically beyond the jurisdiction of the courts, but they are not for that reason lawless. It was early appreciated that society must have some sort of protection. To this end the "miner's meeting" was established as the law-making body. This meeting consists of all the men who inhabit a certain district, or, as the population increased, all who work in a certain gulch. In this meeting every man has an equal vote. A chairman is chosen by the assembly, but his power is slight, and in all cases the majority rules. By this legislative assembly, which, by the way, has no regular time of meeting, but may be called at any time by public notice, all the laws governing morals and mining are passed.

It was by this assembly that Chinamen were excluded from the privilege of mining in the Yukon, and that murder was made a crime punishable by death. But the miner's meeting is not wholly legislative; it is the final court in all criminal or civil suits. Here the majority act as judge and jury, there are none but volunteer lawyers, the weightiest questions are decided, and the decision is generally carried into effect without delay.

At first these hardy pioneers rendered decisions of the most puritanical strictness, and there was little or no crime. In a measure this immunity has been due to the obstacles in the way of entering the country and the extreme difficulty of living when once there; for nowhere is seen a clearer illustration of the principle of the survival of the fittest. The dangers to be encountered upon the "trail" to the diggings, and the hardships to be endured, have weeded out all those unfitted to a pioneer life, and the result is an entire community of sturdy men, capable of almost unlimited physical endurance.

Of late years, however, as might have been foretold, the establishment of precedents has led the miners into several mistakes; at times, perhaps, there has been a personal bias which has made the decisions actually bad. At any rate, among the more conservative miners the "miner's meeting" is not now revered as formerly.

Last summer, in one of the British creeks in the Forty Mile district, there was a clash between the self-appointed government and the Canadian mounted police stationed at Fort Cudahy to preserve order. A claim owner had not paid the men employed by him, and the miner's meeting voted to sell his claim to satisfy this demand; but the soldiers were sent to the gulch, and this decision was rendered void. On the American side of the boundary line there have been no

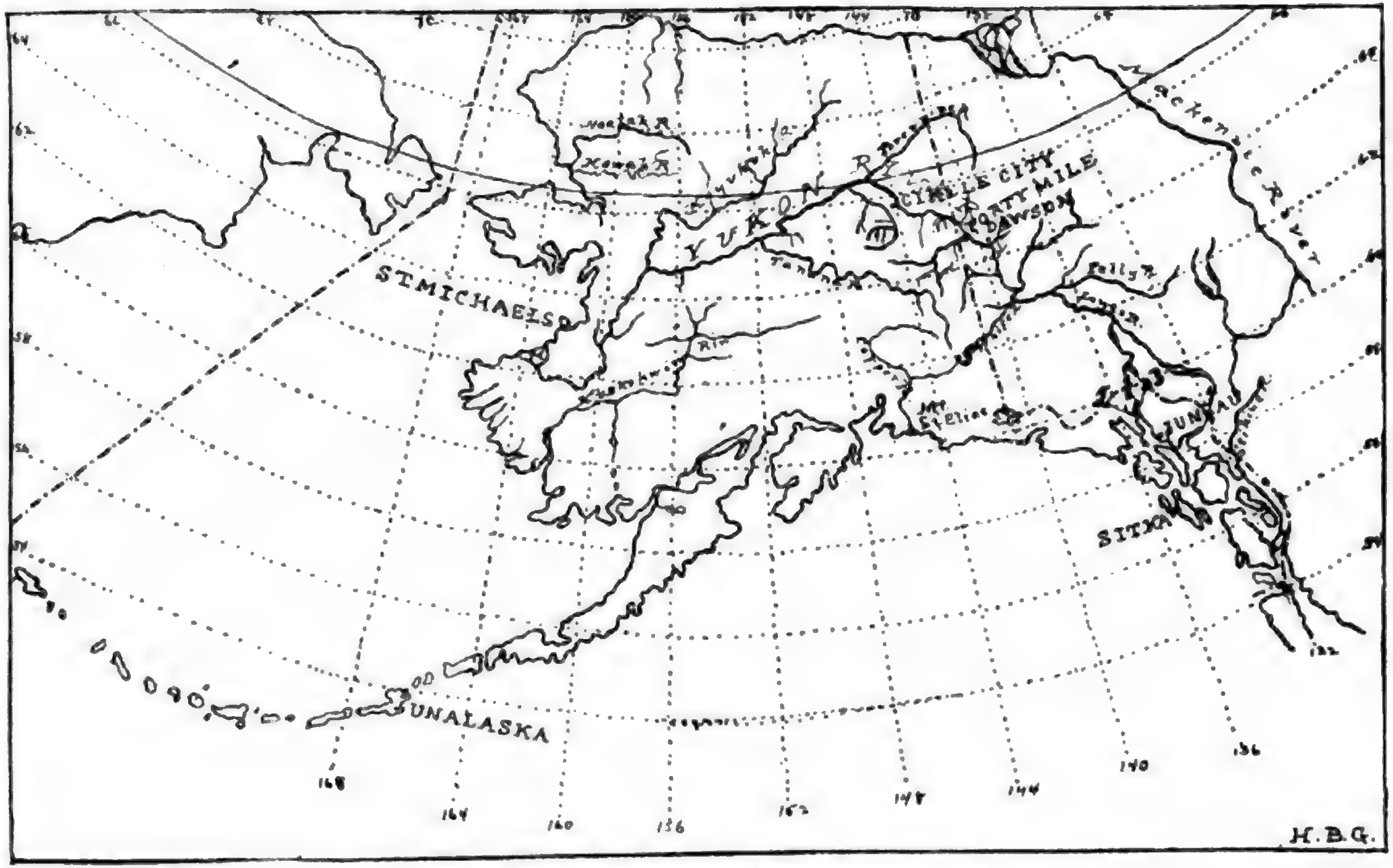
officers corresponding to the mounted police, the only representatives of the government being two custom-house officers sent to Circle City last summer, and the authority of the miner's meeting has never been questioned. Under its rulings, mining has been carried on, and all have lived harmoniously. If, as has infrequently happened, a man has been convicted of stealing,—the crime next to murder in heinousness,—he is whipped at the post and sent out of the country.

Placer mining is the only kind practised, and it is carried on in the most primitive manner. Bar and gulch diggings are the two types of occurrence. The former consist of gravel deposits in the quiet portions of running water, and are found in points of land, or islands in the stream. In earlier days these placers, which contain generally fine and far-carried gold, were the only ones worked. At present, however, although a certain amount of "bar-rocking," as it is called, is carried on along the main stream of Forty Mile creek and others, this form of digging is not nearly so important as that of the gulches.

In the bar the "rocker" or cradle of the Californian days is generally employed. More complicated machinery, however, is used in some localities. Flumes have been built which convey a head of water sometimes a half a mile, and the necessary force for sluicing is also obtained by raising the water from the main stream by a water-wheel. Two of these have been erected, one on Forty Mile and one on Birch creek. They are fifteen feet in diameter, float in mid-channel, and are supplied with cup-paddles. But even with these appliances very few bar-diggings produce more than ten dollars a day per man, which, under existing conditions, is the lowest yield that can be made profitable.

Gulch diggings are deposits of gold-bearing gravels which have been made in the valleys of the smaller creeks. The gold in them is generally coarse, bearing the character of nuggets, and has not been carried to any great distance from its place of origin. Geologically speaking, the gravels are recent, and have invariably been deposited in running water—not by glaciers, as is sometimes thought, for there has been no glaciation in the gold region. They occupy the lowest part of the trenches which have been excavated in the surface by the running water. The present stream often takes a slightly different course from that which it pursued at the time of deposit, the result being that the gravels are cut and exposed at one portion, while at another the water flows over bare bed-rock.

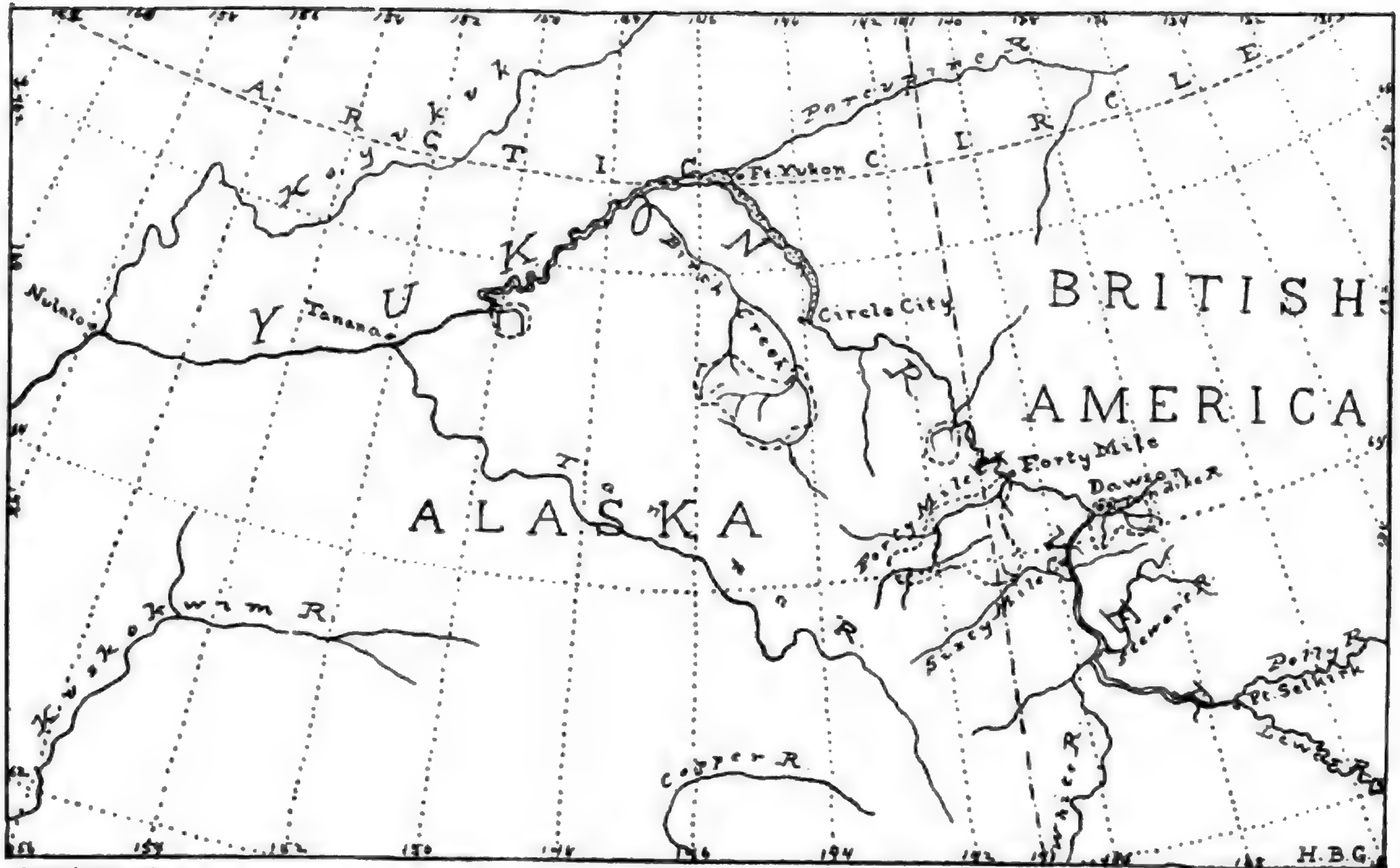
The thickness of the gravel varies from head to mouth of the same creek and between different creeks, and so there is a distinction between shallow diggings, in which the deposit is thin, and deep diggings, where it is from fifteen to twenty-five feet thick. The Klon



Drawn by the Author.

MAP OF ALASKA, AND PART OF BRITISH AMERICA.

1, Chilkat Pass; 2, Chilkoot Pass; 3, White Pass; 4, Taku Pass; 5, Scoloi, or Nicolai Pass.



Drawn by the Author.

MAP OF A PART OF THE YUKON VALLEY.

Showing the areas in which placer mining is being carried on. Scale, approximately 1 in. = 100 miles.

dike placers are of the latter kind, and often in its gulches there are twenty-five feet of gravel deposit between the soil, or "muck," and the underlying bedrock. These gravel deposits are usually not gold-bearing throughout their entire thickness, but are divided into the "barren gravel" and the "pay streak," the latter being generally at the bottom and varying greatly in width and thickness.

In the Klondike district, on Bonanza creek, four feet of pay dirt has been reported with a width of thirty feet, yielding from fifty cents to one dollar to the pan all through. The bed-rock underlying the gravel is often found to contain gold, and it frequently pays to mine this, particularly when it is decayed and loose for a foot or so down. On Eldorado creek in the Klondike district it is said that profitable bed-rock is three feet thick.

Having found the pay streak under the mass of barren gravel, the prospector pursues different methods to reach it. If there is no great thickness of gravel, the miner "ground-sluices" the claim with the water from the creek, and, having stripped the gravel, shovels it into sluice-boxes, where the heavy metal is separated from the lighter gravels and is caught by the strips called "riffles" on the bottom of the boxes. It is finally recovered in the "clean-up" by amalgamation with mercury. This is done in the summer-time, and the amount of production depends largely upon the accidents of climate, for the working time may be cut short by the continuance of the spring flood period, or toward the middle of August drought may come, and last until the country freezes up in the middle of September.

Thus it happens sometimes that a summer's working-season is only sixty days long, and it is obvious that claims must be very rich indeed to make up for that short season. To obviate this difficulty, the miners have endeavored to extend their operations to cover the whole year, the severe winter as well as the genial summer, and the method of "burning and drifting" has been evolved. For these "winter workings" shafts and tunnels are driven, as in ordinary bed-rock mining, through the frozen gravel, but, in place of powder or dynamite, fire is used. A large blaze is built upon the surface, and by it the ground is melted. The thawed ground is then removed, and a shaft is started. By continuing the process the shaft finally reaches the pay streak, which is mined and laid by in dumps until the water flows in the spring, when it can be washed.

It can be seen that this is particularly advantageous in deep diggings, and it is a fact that all the large "stakes" have been taken out by winter working. For instance, previous to the development of Klondike, the largest amount ever taken out on one claim was $45,000, won by John Müller, on Miller Creek of Forty Mile District,

"TRACKING" TO THE GULCHES.

Drawn by H. T. Pratt from a sketch made on the ground by the author.

mainly by "burning and drifting." Klondike itself has typical winter workings, and it was by this process that all the large amounts of gold brought to San Francisco in July were extracted.

Until the discovery of Klondike the development of the interior had progressed in Alaska proper, toward the west, and the output had increased until in 1896 the production, exclusive of that in British territory, was in the neighborhood of $1,000,000. All this (as later the $2,000,000 or more of gold from the Klondike) was taken out by summer and winter workings with a minimum outlay of capital. The miners have whipsawed their lumber themselves, and made their own simple sluices and cradles, which, with gold pan and shovel, have constituted their entire mining outfit. Hydraulic mining has not even been attempted, and, while there is much gold-bearing quartz through the different placer areas, the expense of all kinds of machinery has precluded actual "quartz mining." It has, in fact, been the bane of the country that, on account of its severe climate, it is not self-supporting, and that difficulty of communication with the "States" has made the cost of living extraordinarily high. Correspondingly wages are high,—$10 a day, or a dollar an hour, and, during the first of the Klondike excitement, even higher. This is the reason why all placers whose product falls below $10 a day for each laborer must be abandoned, as stated above.

An expert on gold and gold mining, Mr. Joseph De Lamar, recently published the statement that Alaska can never be compared with California, because of the difficulty of living there. It is undoubtedly true that the severe climate has greatly delayed the development of Alaska. Few wished to invest capital in a country where, because of its isolation during the long winter, the risk is so great and the returns so slow. To a certain extent, however, these difficulties can be overcome, and, if the Klondike stampede is for a time disastrous because of its unexpectedness, in the end it will undoubtedly be highly beneficial. The tide of capital has set that way. Alaska will no longer be a "poor man's country," but, by the competition which will obtain between rival companies, it may reasonably be expected that the cost of living will be materially reduced, machinery be brought in, and mining in an improved form be put on a permanent basis.

In order to accomplish these results, ingress and egress must be made easier. Up to the present time there have been two principal routes by which the gold fields are reached. One is by steamboat from Seattle or San Francisco, across the North Pacific to Unalaska in the Aleutian Islands, and thence to St. Michael's near the mouth of the Yukon. From here a transfer is made to the flat-bottomed river

GULCH MINING.

Drawn from a sketch made on the ground by the author.

steamboats which navigate as far as Dawson City, a distance of nearly 1,800 miles. Supplies have heretofore been brought into the country in this way by a journey of 4,000 miles, but the miners prefer the second route over the Chilkoot pass, by which they can reach the diggings about a month earlier. The Chilkoot pass route is full of difficulties, as is well known. Generally the miner crosses it in the early spring, before the lakes at the head of the Yukon are clear of ice, builds his small boat on Lake Linderman, and sails down the river, carrying his provisions with him.

The point he most dreads is the Miles cañon, where the Lewes river narrows to fifty feet and plunges between basalt walls at a rate of twenty miles an hour. The cañon itself is only five-eighths of a mile in length, but there is a vast amount of experience crowded into the few seconds of its passage. As one miner expressed it after going through the cañon:

"I wouldn't have missed that trip for fifty dollars!" and then significantly added: "But I wouldn't make it again for five hundred."

The cañon spreads out in the middle, forming a circular eddy, and a story is told of two Swedes, whose boat, carried out of the main current, circled about in this central basin for many hours, while they were wholly unable to guide its course. At last, when they were worn out with terror and fatigue, a caprice of the current sent them dashing and plunging unexpectedly through the lower part of the cañon. The White Horse Rapids, three miles below this dangerous spot, is even worse, and in its turbulent plunge many valuable outfits and even lives have been lost. There are also other less dangerous rapids still further down, through which the miner passes on his way to the camp.

While the ocean voyage and passage up the river will, of course, be maintained on the lower Yukon for purposes of traffic and supply, some more direct route to the gold fields of the upper river must be established in the future. The journey by way of the Chilkoot pass—"over the trail" in the language of the miners—is the shortest one to the headwaters of the Lewes river, but, on the other hand, from the salt water at Dyea across the Coast range to Cañon lake, the way is one of the greatest difficulty. The summit of the pass is 3,560 feet above sea-level, and is reached only by the hardest climbing. It is obvious to all who are acquainted with this region that a railroad through it would involve an immense expense.

There is, however, another pass, which crosses the coast range a little further to the southeast. This is known as White pass (No. 3 on map), so named by Mr. Wm. Ogilvie, the experienced Canadian surveyor, in honor of a Minister of the Interior of the Dominion. Its

SHOOTING MILES CAÑON.

Drawn from a sketch made on the ground by the author.

altitude is 2,600 feet above the sea. From the mouth of the Skagway river in Taiya inlet to its summit the distance is seventeen miles, nine of which are said to be through a cañon which presents great obstacles; but the approach to the lakes on the north of the Coast range is easy, and the route is reported to be practicable. It is lately reported that the Canadians have built a trail through it, and are laying a telegraph line into the interior.

Supposing the headwaters of the Lewes to have been reached by a railroad through either the Chilkoot or the White pass, the river affords an easy line of travel for four months of the year. During this time, while it is free from ice, flat-bottomed steamboats of light draft can be used. The main difficulties to be overcome are shallow water and rapids. Light-draft steamers on the Lewes could pass all these, with the possible exception of the White Horse, which, however, with the Cañon, could be avoided by a steamboat route through Lake Ahklen down the Hootalinqua river. An entrance to this line would be made through the Taku pass (No. 4), about 75 miles from Juneau. Its feasibility as an approach to the interior was demonstrated by Schwatka and Hayes, who in 1891 made the trip through it to the Yukon valley. The objection to this route is its length.

As I have stated, the river would be open to travel only from the middle or last of May to the middle of September. It might be advisable, then, to have a railroad down the Yukon. Could one be put through cheaply from salt water to the diggings? Chilkoot pass is unsuitable; so one of the others must be utilized. The topography of the upper lake country is that of rugged, steep mountains. The snowfall in winter is not deep, yet deeper than in the gold districts, and blizzards are frequent. The difficulty of building and maintaining a railroad would be considerable.

At Mud Lake the country becomes flat, and is characterized by rolling hills, into which the streams have cut narrow valleys. This type of typography continues as far as Fort Selkirk, one hundred and fifty miles above Klondike, where the Rampart mountain range crosses the river. This Rampart country, with its cliffs and mountains, presents many obstructions to travel. Altogether, a railroad down the Lewes valley would be rather rough. However, there is still another pass about fifty miles northwest of the Chilkoot. It is called the Chilkat pass, and is said to be much lower than the one usually taken by the miners. It is through this that Jack Dalton, a well-known pioneer, has led a train of cattle by a short route to the gold fields. This line of travel is known as "Dalton's trail," and by it one can pass overland through a level grassy country to the confluence of the Pelly and Lewes rivers. The time necessary for making this trip on foot is said

LAKE LINDERMAN, LOOKING NORTH.

Drawn from a sketch made on the ground by the author.

to be only fifteen days, and it is thought that this, the most direct route of all, may become the main line into the interior.

Besides the ways mentioned, various others have been suggested; the route up the Stikine river, crossing overland to the Yukon from Telegraph creek, is perhaps the best of these, since it is open as late as October, while travel by the others becomes dangerous by the first week of September. Another route from the east through Northwest Territory to the Mackenzie river, thence westward to the Porcupine and down to the Yukon, is said to be contemplated by a Canadian company. This, however, would be a long route, and would lose the advantage, possessed by the Stikine line, of passing through the Cassian and other gold districts of British Columbia.

The miners, however, not only look forward to easier means of entering the country, when "grub" will be much cheaper and easier to get than now, but dream of wagon roads from the towns to the diggings. When these are put through, they will no longer be obliged to "pack" their outfits on their backs and carry them through mosquito-infested swamps, or to tow their boats a hundred miles against a rapid current. While such a condition is still in the dim future, it is within the limits of possibilities. The move has been made in the right direction, and in a few years Alaska may not be so bad a place to live or travel in.

THE PRESENT STATUS OF THE HORSELESS-CARRIAGE INDUSTRY.

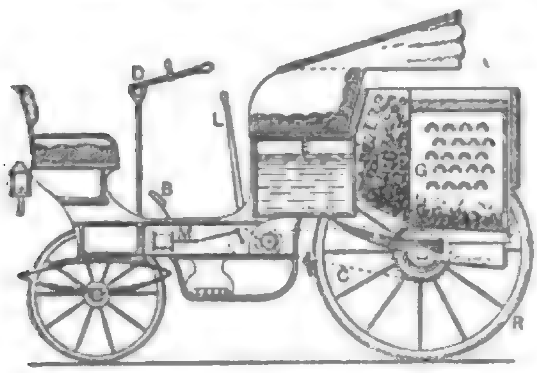
By W. Worby Beaumont.

THE motor-car industry in Europe to-day affords a remarkable illustration of the great distance or difference there may be, and usually is, between a "good makeshift" and a thing which is so far on the road to practical perfection that possible improvement is not obvious on inspection. The difference may be only in finish, or in those matters of design which affect appearance; it may be in imperfections of essential mechanical parts; it may be in both. In the motor car the difference has been and is chiefly in mechanical imperfection. When attention was widely directed to the motor cars of Paris by the races organized by the *Petit Journal* in 1894, the makeshift stage was reached. In 1896, when the Paris-Marseilles race was run, the good makeshift stage was approached, and may now be said to have been reached. With the carriages of several makers, journeys at considerable speed and of long distances were not only possible, but possible under very trying conditions as to roads, hills, and weather. These carriages, nevertheless, were susceptible of much desirable improvement, or were open to several objections. These objections were obvious, but the means of removing them were far from being so. Invention was and is necessary to their removal by means in themselves unobjectionable.

Meanwhile the motor carriages made by several firms realized the chief aims of their construction,—namely, to carry people or goods at a desirable speed. To many who want to be carried or have goods carried, the accomplishment of these aims is of the first importance; to others the imperfections outweigh this importance, and these others are mostly critics, who would rather forego, and cause others to forego, the advantages of the motor car than tolerate its imperfections. They had rather leave work undone than perform it with a good makeshift tool. This attitude of mind has done immense harm in England by delaying the progress of the motor car, just as in other days it delayed the introduction of railways and machinery,—the compound engine, the triple-expansion engine, and high-pressure and traction engines,—and would even now cause us to be without railway communication in and around London, because the engines smell and smoke and the trains make a noise, cause some vibration, and run on unsightly viaducts. Business men, however, seize upon the useful

and encourage improvement and the gradual removal of objectionable imperfections. They reap the advantages of the good makeshift, thus profitably covering the long distance that separates it from the thing which the designer ceases to improve, and at which the irresponsible critic ceases to cavil.

Much as was accomplished in England in the ten years ending in 1834 in the construction of steam coaches, it has remained to the French to bring attention to the advantages of motor vehicles for use on common roads.



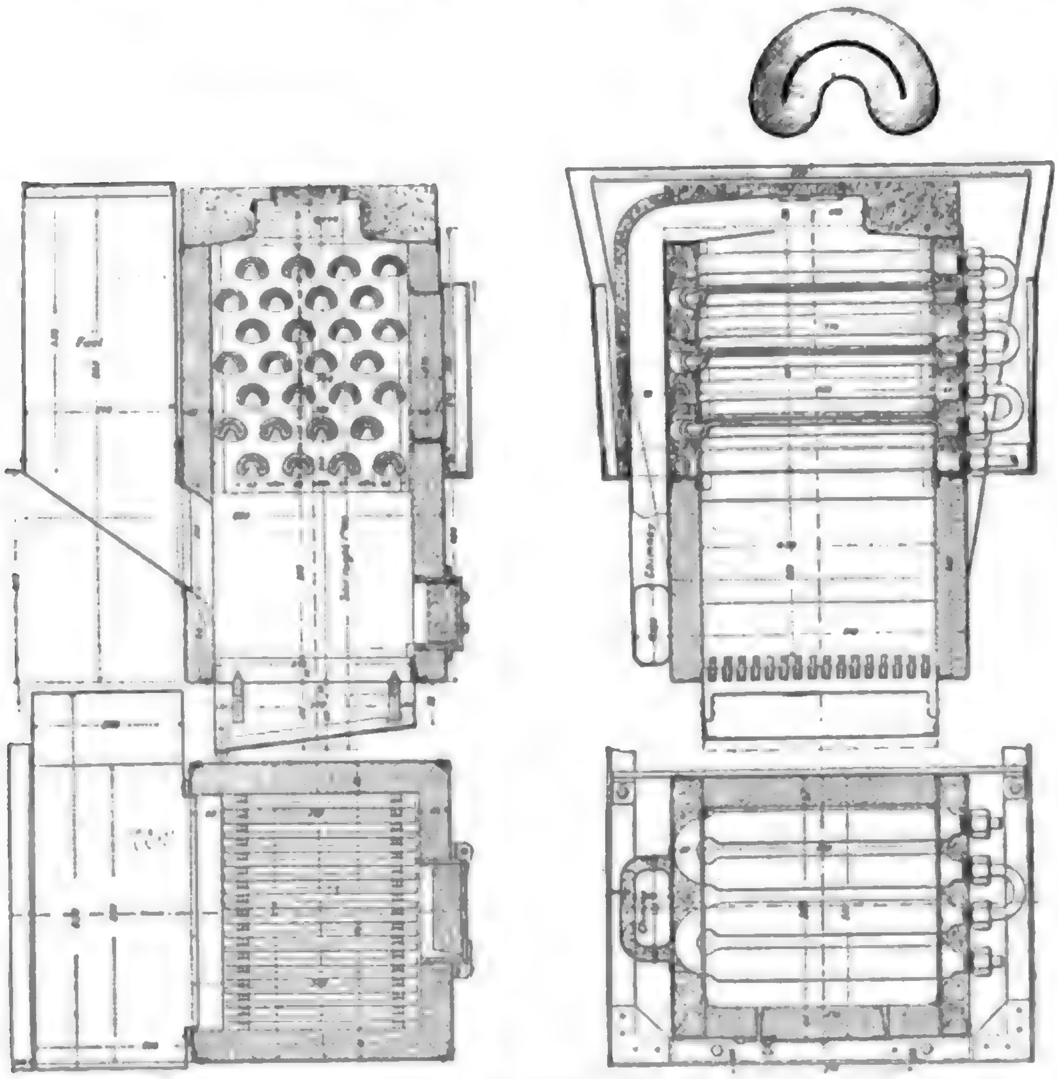
SERPOLLET STEAM CARRIAGE (1895).

The Engine in the 1897 pattern Serpollet victoria is vertical, and is placed by the side of the generator. A, generator; M, engine; L, hand-pump for injecting water before engine starts; E, water tank; B, brake; D, steering and stopping handles; C, chains.

Serpollet, Scotte, Le Blant, de Dion, Bollée, and others brought forward steam vehicles of different forms, the peculiar advantages of the Serpollet generator making it the special object of attention in 1891. In that year not only did Serpollet make very successful vehicles, but one of them was sent to England; and it and its new steam-generator were exhaustively tested with most satisfactory results. As, however, the laws of England prohibited the use of such vehicles until November, 1896, and even now prohibit them as then made, without reversing gear, nothing was done in England. In France such things may originate, but they do not, as a rule, develop quickly into a great commercial industry. Witness the gas engine. The introduction of the light oil or mineral spirit motor enabled Frenchmen to construct and develop the *automobile*, which, without doubt, would have done in England but for its repressive laws; for the first vehicle propelled by a spirit motor was made in that country in 1883 by Edward Butler. The motor designed by Daimler was, however, the real starting-point of the recent revival of the mechanical road-carriage. It was designed as a motor for the usual miscellaneous purposes, and was applied by him at an early date to the propulsion of a vehicle; but its most extensive employment was as a boat-propeller. For this it was much used in Germany, France, and England, and the name of its inventor was widely known before the motor was so successfully applied to motor cars by MM. Panhard & Levassor, of Paris, MM. Peugeot Frères, of Valigntiny, and others.* A horizontal form of spirit motor was subsequently made by Herr Benz, of Mannheim, and was applied by him and by M. Roger, of Paris, to the propulsion of a vehicle;

*See Cantor Lectures by the author, *Soc. Arts Journal* reprints, 1896.

and the count de Dion applied a spirit motor of the Daimler type to tricycles. Before the middle of 1894 the steam vehicles mentioned, and these spirit motor vehicles, had attracted the attention of those who saw great possibilities in them, and in that year the *Petit Journal* offered numerous prizes for the best motor carriages of several kinds, with the result that in July a large number ran in trial races between Paris and Rouen. As the types of vehicles which ran in this race still hold



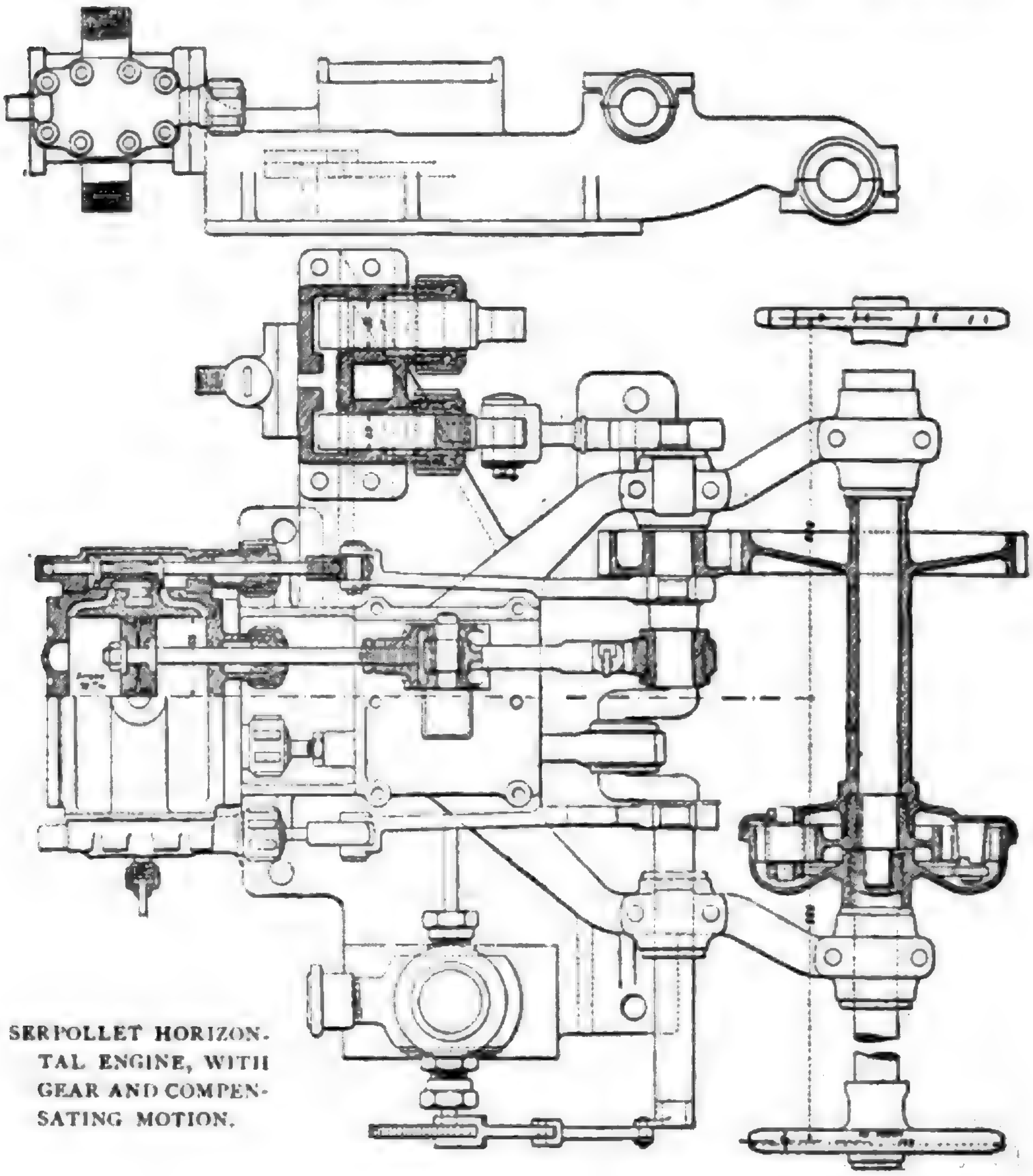
SERPOLLET GENERATOR.

the foremost position, they must be here referred to. Of 102 vehicles entered, 46 appeared for the race of 79.36 miles from Paris to Rouen These were propelled by motors of the following types:

Petroleum spirit motors, mostly Daimler, 23; steam, 12; steam and petroleum spirit, 1; compressed air, 2; compressed gas, 1; electricity, 1; various, 6. Five of these, differing in form of vehicle and in seating-capacity, were entered by Messrs. Les Fils de Peugeot Frères, and four by Messrs. Panhard & Levassor, all fitted

with Daimler motors. Messrs. Dion, Bouton & Co. sent a steam carriage for six, and a steam tractor with bogie for four; M. J. Scotte sent a steam vehicle to seat eight or ten, and M. Maurice Le Blant sent two steam brakes, fitted with Serpollet boilers and seating nine or ten persons. MM. Vacheron and Le Brun sent carriages worked by Daimler motors slightly modified, and M. Roger sent a carriage fitted with a Benz motor. The journey was made by the Dion steam tractor and carriage at an average speed of 10½ miles per hour, and at similar speeds by the Panhard & Levassor and the Peugeot four-seat carriages fitted with Daimler motors.

The prizes awarded in 1894 were: First prize, £200, divided between MM. Panhard & Levassor and MM. Peugeot Frères; second prize, £80, MM. Dion & Bouton. This vehicle was first in,



SERPOLLET HORIZONTAL ENGINE, WITH GEAR AND COMPENSATING MOTION.

but it was considered more suited to heavy work than for carriages; third prize, £60, to M. Le Blant, for his steam carriage; fourth prize, £40, divided between MM. Vacheron and M. Le Brun for improvements in details of their Daimler motors; fifth prize, to M. Roger; a sixth, or consolation, prize, £20, to M. J. Scotte for his steam vehicle, which worked well until one of the Field tubes with which his boiler was fitted burst.

Now, as showing which type of vehicle has best survived the ordeal of the French trials, and the equally valuable trials of every-day use, we must look at the results of the Paris-Bordeaux race of 744 miles for the double journey in 1895, and of the Paris-Marseilles race of no less than 1,070 miles in the autumn of 1896.

For the Paris-Bordeaux race, which was continuous day and night, only such repairs being permitted as could be done by the occupants with tools carried with them, the driver could be changed, and any vacant place had to be filled with 165 pounds' dead weight.

Twenty-nine vehicles were entered, including several steam carriages, one of which, the Dion steam drag, led for about 120 miles, after which the petroleum spirit motor carriages took and maintained the lead. A Panhard & Levassor two-person carriage completed the run in 48½ hours, an average speed of 15.3 miles per hour, but, as it carried only two, it was not eligible for a prize. All the prizes, with one exception, went to petroleum spirit motor carriages, as follows:

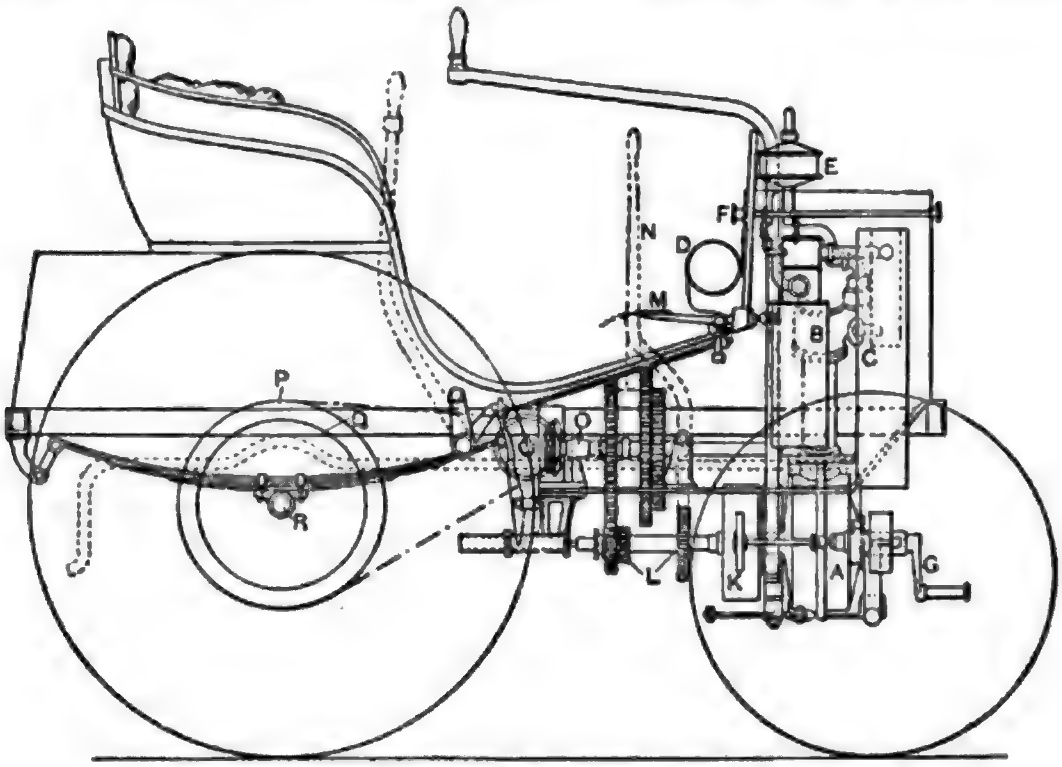
First, third, and fourth prizes, to Peugeot Frères; second, sixth, and seventh, to Panhard & Levassor; fifth prize to M. Roger (Benz motor); a special prize to M. Bollée for a steam omnibus, which accomplished the run within the maximum of 100 hours, and came in ninth. This omnibus M. Bollée built in 1880. It had a small vertical boiler 30 inches in diameter inside, with 118 Field tubes, and worked at 140 pounds.

Before referring to these vehicles in detail, the evidence of fitness by survival, after ordinary every-day use and further and even more severe race trials, must be examined. Between the Paris-Bordeaux race in June, 1895, and the Paris-Marseilles race of 1,070 miles in September, 1896, a year and a quarter elapsed. This, for men who had had all the preceding experience with petroleum spirit motors, steam, compressed air, and electricity, gave opportunity for long thought. Prizes for three types were offered,—namely, (1) vehicles with two, three, or four seats; (2) vehicles with more than four seats; (3) motor cycles.

In Class 1 all the vehicles entered, and the prizes were won by those propelled by petroleum spirit motors. In Class 2 three steam

carriages were entered, two by MM. Dion & Bouton and one steam omnibus by MM. Chasseloup & Loubert. In Class 3 five motor tricycles were entered, three of them by M. Dion.

The results of the Paris-Marseilles race, which was not run during the nights, were as follows. In Class 1 first, second, and third prizes went to Panhard & Levassor, who accomplished the 1,070 miles by three vehicles in 67 hours, 42 min., 58 secs.; 68 hours, 11 min., 5 secs.; and 71 hours, 23 min., 22 secs., respectively, or a mean speed for the three vehicles of 14.1 miles per hour, and a mean speed for the fastest vehicle of 15.8 miles per hour. Fourth and sixth prizes went



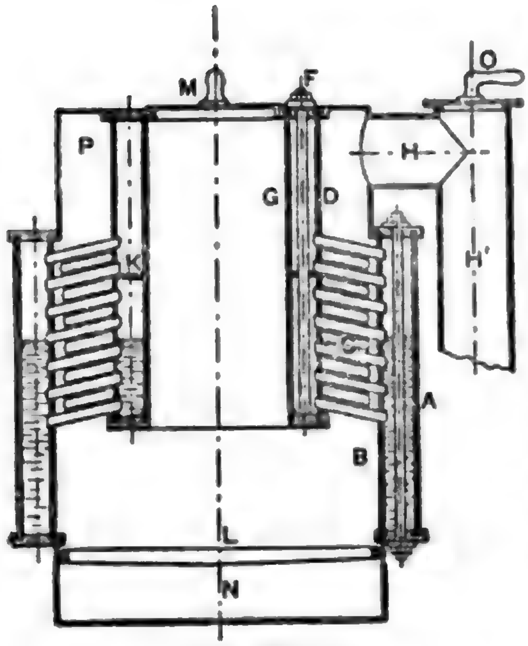
PANHARD AND LEVASSOR'S DAIMLER MOTOR CARRIAGE.

A crank box of vertical Daimler engine, B, with crankshaft carrying clutch, K, and three alternative speed wheels, L, gearing into wheels on second motor shaft, O, which drives chain wheel shaft by bent wheels and compensating gear. Chain wheels on each side, P, and brake wheels, Q. N, brake lever; M, foot control of brake and clutch; E, automatic oil flow regulator and, A, handle for starting motor.

to M. Delahaye, who accomplished the journey in 75½ hours and 84 hours 27 minutes with his two- and four-seat carriages respectively. Fifth prize went to MM. Peugeot Frères, who took 81 hours, 24 minutes. Seventh prize went to the Maison Parisienne, and eighth prize to MM. Landry & Beyroux.

In Class 2 first prize was awarded to MM. Peugeot. In Class 3 the three prizes were awarded to Dion petroleum spirit motor tricycles, one of which performed the double journey in 71 hours, 1 minute, or at the rate of more than 15 miles per hour.

The steam carriages met with various difficulties, and retired. No



DION BOILER.

A, outer shell ; B, inner shell ; C, radiating water and steam drying tubes connecting outer water shell to inner shell, G D. Fuel is fed in at cover, M. H, chimney.

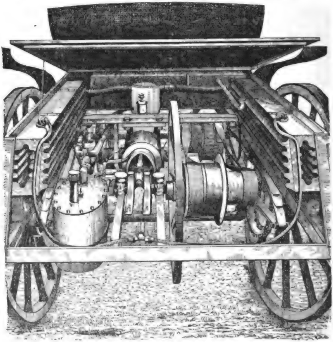
Serpollet vehicles were entered for the Marseilles race, M. Serpollet being too fully occupied in the construction of self-propelled steam tram cars, which are now so largely used on the Paris tramways. A race was run on July 24, 1897, from Paris to Dieppe, a distance of 105.4 miles. There were entered 69 vehicles, of which 55 appeared, including about 40 motor carriages and 15 motor tricycles and Bollée voiturettes. Of these 30 arrived at 4 P.M., the first starting at 9.5 A.M. The carriages included a Dion & Bouton steam brake, or wagonette, capable of carrying about ten people, including driver and attendant. This vehicle is fitted with one of the count de Dion's boilers, working at a pressure of about 240 pounds per square inch and capable of 15 to 16 h. p. and even more for short periods for mounting hills. The engine is of the Dion-Bouton type, and will propel the vehicle at any speed up to 35 miles an hour, and did the run from Paris by St. Germain to Dieppe at a mean speed of about 25 miles per hour. It runs with great steadiness, and even at the high speeds steers with the greatest precision.

The larger number of the mineral spirit motor vehicles were entered by MM. Panhard & Levassor; two however, were entered by M. Delahaye, and two by Peugeot Frères, one of which, a Victoria, had just arrived from Varsovie (Warsaw) *via* Belgium, the owner doing the 1,800 kilometers in 10 days. This carriage had run 700 kilometers before it started from Varsovie, and, after it had done about half the run from Varsovie, a total of 1,600 kilometers, new chains were put on, no other repairs or renewal of any note being made. These chains run unprotected from the dust and mud, and would probably run three or four times the distance.

M. Gauthier Wehrlé also sent some new carriages, including a very convenient little wagonette for four. The motor in these vehicles is a spirit motor. MM. Landry & Beyroux sent vehicles with vertical spindle cylinder motors, which worked well, and MM. Bollée also sent two spirit motor carriages driven by gearing with skew teeth instead of by chains. The Bollée voiturettes and Dion tricycles per-

formed most excellently, although some of the voiturettes are rather noisy, the noise arising from the powerful exhaust and the gear,—no wonder, considering the tremendous speed (25 to 30 miles an hour) these vehicles make.

M. Roger also sent carriages of his make, with the well-known Benz motor, and M. Mors sent two with his four-cylinder motors.



REAR VIEW OF ROGER VICTORIA AND BENZ MOTOR.

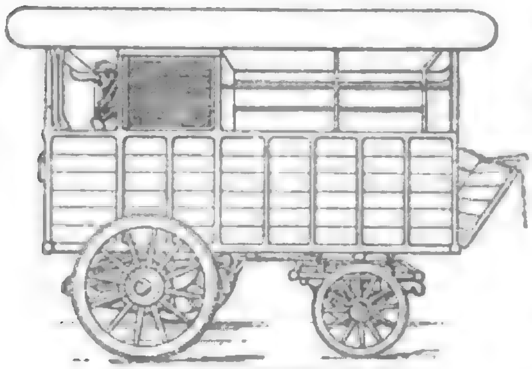
From all this it will be seen that the victory has been almost entirely, year after year, with the carriages propelled by mineral spirit motors. It must, however, be noted that most of the prizes have been offered for, and have gone to, carriages carrying from two to four people. When larger numbers have had to be carried, steam has done good work, but only a few of the steam carriages have been small and light enough to run under the conditions which the oil motor vehicle is competent to meet. M. Serpollet made a number of excellent victo-

rias, but their weight, although less than that of other steam carriages, was more than that of the oil motor carriages. This alone, although the variable power of the steam, and especially in the Serpollet, is a most valuable qualification for good and bad road-travelling and hill-climbing, has given the light oil motor carriages every advantage. Every adverse condition of running at high speeds on common roads increases enormously with increase in weight. As soon as the weight is above that at which rubber tires can be used, speed must suffer a reduction of 30 to 50 per cent.; else wear, tear, breakage, and loss of power will result, with attendant discomfort for riders. The lighter Serpollet victorias of the type most recently made are light enough to be fitted with rubber tires. They weigh only about 1,500 pounds, and, as they offer the many advantages of steam, they will probably remove many of the objections raised against the oil-motor-driven vehicle.

The experience in England with the lighter types of vehicles propelled by mineral spirit or oil is limited in comparison with that of the French,—not perhaps one-fifth. So far as it has yet gone, it has only confirmed the facts proved in France,—that the carriage driven by the mineral spirit-motor is a very excellent makeshift, and, as now made by Panhard & Levassor, Peugeot Frères, Roger, and Delahaye, very difficult to improve or to describe as open to obvious improvement. They may be open to obvious objections, including vibration when the carriage is standing, and occasional smell of incompletely-burned oil when frequent stoppings and startings are imposed by street-traffic conditions; but both these are objections which are lessening with almost every carriage that is built, although the means of their complete removal cannot be specified off-hand. In the early days of locomotives coke ovens had to be put up as part of every great railway establishment, because for years they could not burn coal. The way to get over this difficulty could not be discovered in the hurry of a few months, but, after some years of every-day use of locomotives, the difficulty was removed in the simplest manner, the locomotive being used all the time, but denounced by every critic, whose useless and obstructive part is followed by similar critics of to-day concerning motor carriages.

There are now running in England a number of mineral spirit motor carriages and motor vans made in England, and with Daimler, or Benz, or similar motors; and their success is undoubted, although improvements will be constantly made.

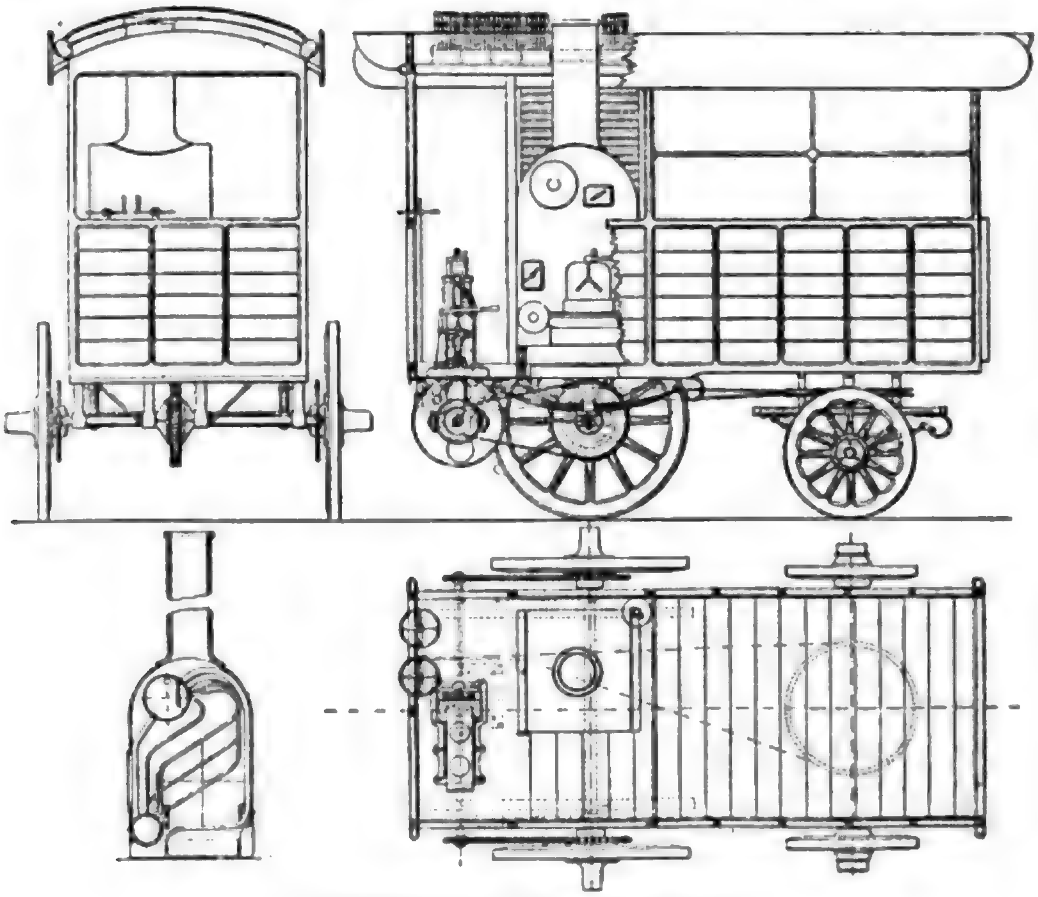
The construction of motor vehicles is already a large industry in France,—an industry which would be much greater if the French were greater masters of the art of organizing and main-



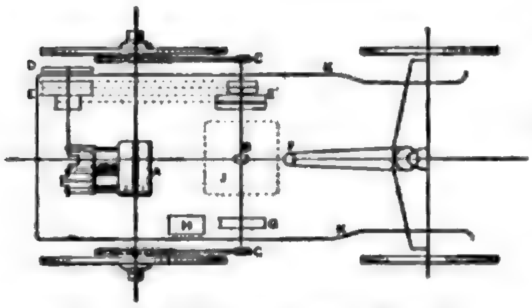
THORNEYCROFT VAN.

taining energetic manufacturing development in new lines. Certain types have survived, and the processes of selection and rejection which have preceded this survival have taught useful lessons.

Of the Serpollet steam vehicle, which was earliest in the recent renaissance of the mechanical road-vehicle, it is not necessary to say much, for it is well known. The generator is the key to the whole of the remarkable success of the Serpollet for tram-car purposes in France. It is made of tubes of crescent section and with an interior space of not much more than capillary thickness for the small boilers. Water is forced into these tubes in series, by a pump worked by the engine, the pump working against a loaded valve. The two lower rows of tubes nearest the fire receive the water from the pump all the time the engine is running, but, if the pressure in the boiler is sufficient, the loaded valve and its connections permit the water to return to the water-tank, and in this way the lime deposits are constantly removed.



THORNEYCROFT STEAM CARRIAGE.



DELAHAYE'S CARRIAGE (PLAN).

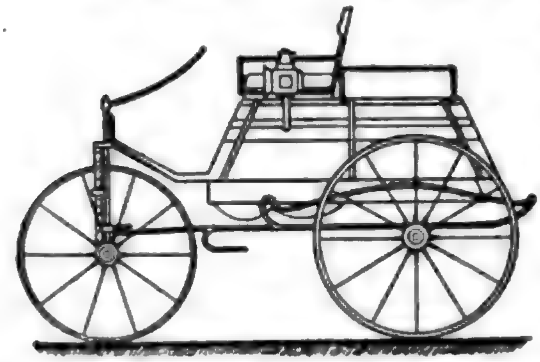
Although it might be expected that the boilers would soon be clogged with the incrustating deposits, this is not the case, and an occasional washing out with a dilute solution of hydrochloric acid of 1 to 7, which can be done in five minutes, is all that is required in any case. The advantage of this generator is that it makes no steam when none is required, and needs no attention from the driver, who has no fear as to water-level and none as to steam blowing-off at a safety valve when the vehicle is stopped in the streets. The engine of the Serpollet motor carriage, as of the tram cars, was of horizontal form, but in the most recent form of small steam victoria M. Serpollet is using a small double-cylinder vertical engine, and a vaporized liquid-fuel burner is being experimentally used, superior to the Longeunial burner which M. Serpollet had been employing instead of coke.

The de Dion & Bouton boiler and engine are practically the same as those so many times illustrated and described. (See the writer's Cantor Lectures, Society of Arts, 1896, and paper before same Society, 1896.) It is one of the high-type boilers of small content compared with heating surface, and one the water-level of which and the pressure gage of which must be under constant attention.

It is not pretended even by the count de Dion that this type of boiler will suit the requirements of vehicles of the victoria or brougham classes, which receive the attention of only one person,—namely, the driver. For these vehicles the steam generator must automatically vary its activity by simple means, in accordance with the work the motor has at any moment to perform. This is one of the points that very extensive experience may be said to have definitely proved. A light carriage cannot provide room for a boiler attendant, yet this is absolutely necessary for any form of steam generator which does not take care of itself, as the Serpollet does. For the heavier vehicles, such as trade vans for goods delivery, requiring in any case two attendants, this is not of so much importance; but in all other cases, including tram cars, it is essential. On the other hand, generators carrying a considerable quantity of water and having large steam space are equally inadmissible, because of weight and size and because of all the foregoing objections, except a slightly-lessened demand for anxiously perfect stoking, or, if oil fuel is used, perfectly automatic correspondence between not only steam pressure, but steam consumption, and fuel-supply.

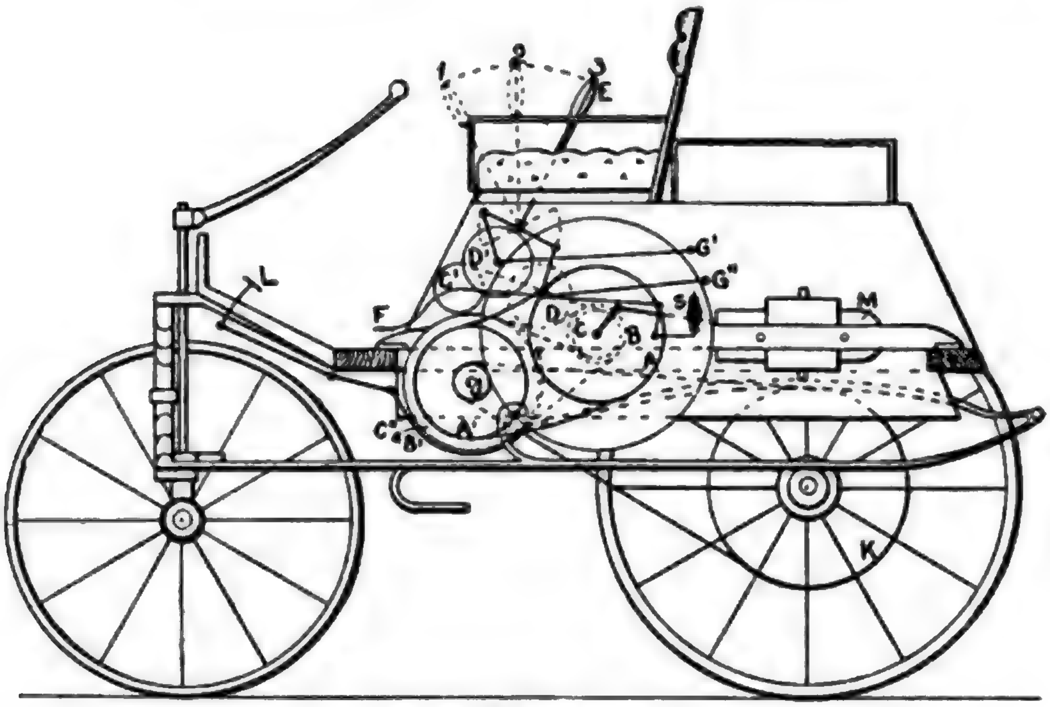
The vehicles operated by mineral spirit motors are most largely represented by those of Panhard & Levassor, which have the vertical Daimler-Phoenix spirit motor placed over the fore carriage. These are now essentially the same as in 1895, and the same may be said of the Peugeot carriage with the motor in the rear. In both the motor is connected to a second motion shaft and compensatory motion by means of three or four sets of spur gear wheels and pinions, of which one set is capable of sliding on its shaft to enable one or other of the sets of teeth to engage. From this shaft the driving-wheels are actuated by uncovered pitch chains. This form of gearing does not satisfy mechanical aspirations, but in practice it succeeds much better than could be expected, although the spur wheels are of steel and make a rattling noise. Enormous distances have been run with it by large numbers of vehicles in many hands, and renewal in this respect is very rare.

The chains, which, it may be observed, are not now so scanty in dimensions as those which some of the makers were wont to use, need renewal much more frequently than will be necessary when the constructors have found out how to make an easily-fixed, detachable, fairly dust-tight gear-case. This, of course, is not the simple problem that it is with a bicycle, as the vertical movement of the road wheels is not coincident with that of the vehicle; but, when makers and owners no longer fear to make their chain less accessible, the gear case will be forthcoming. In the beautifully-furnished brougham of the baron de Zuylan the chain is partly covered.



PETTER AND HOLLES' 4-WHEEL DOGCART.

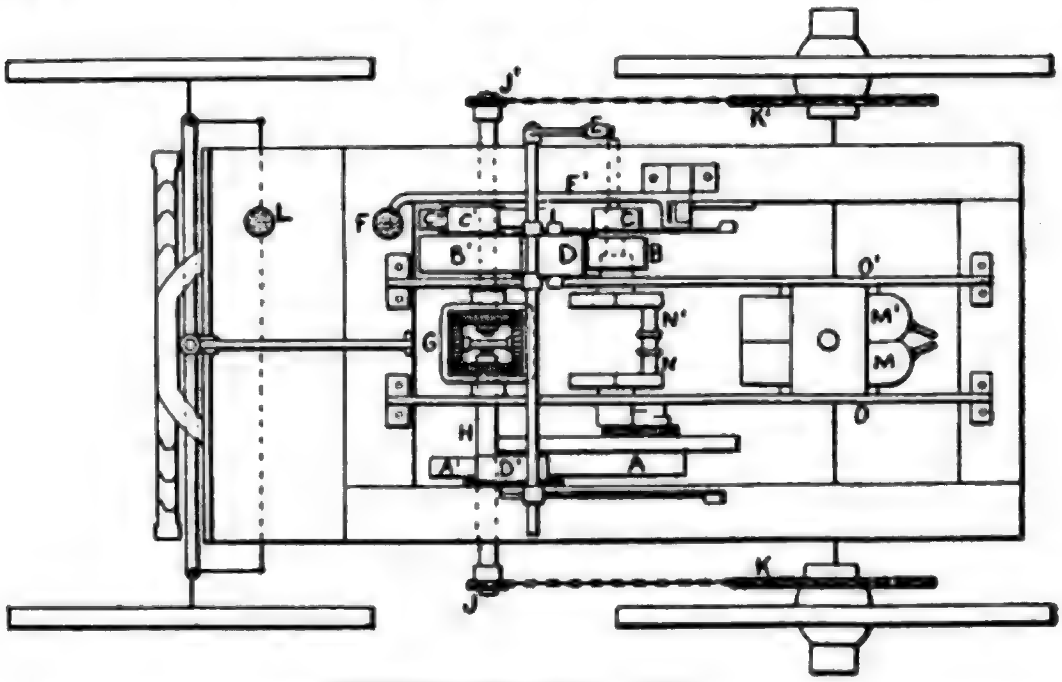
In many of the vehicles, including those of Delahaye, Mors, and Roger, the motor drives the second motion shaft by means of crossed leather belts, except that required for reversing. Two sizes of driving and driven pulleys are used, and speeds between these for manipulating in traffic are obtained by putting the belts more or less on the fast or loose pulleys. This again does not appeal successfully to the mechanical mind, but it appears to satisfy practical requirements until something better shall be found, and, after all, it is as good as the slipping or tight leather belt for hoisting which has been successfully used for generations in flour mills and elsewhere. The ordinary carriage brake, with a block rubbing on an iron tire, well supplied as it always is with excellent grinding sand, is a mechanical barbarism



PETTER'S DOG CART.

as compared with the electro-magnetic brake, in which the resistance is afforded by the invisible distortion of magnetic lines of force. But the common brake block is a good makeshift.

The spirit motors used by Roger—namely, the Benz—are of the single-cylinder horizontal type, with electric ignition, and these have



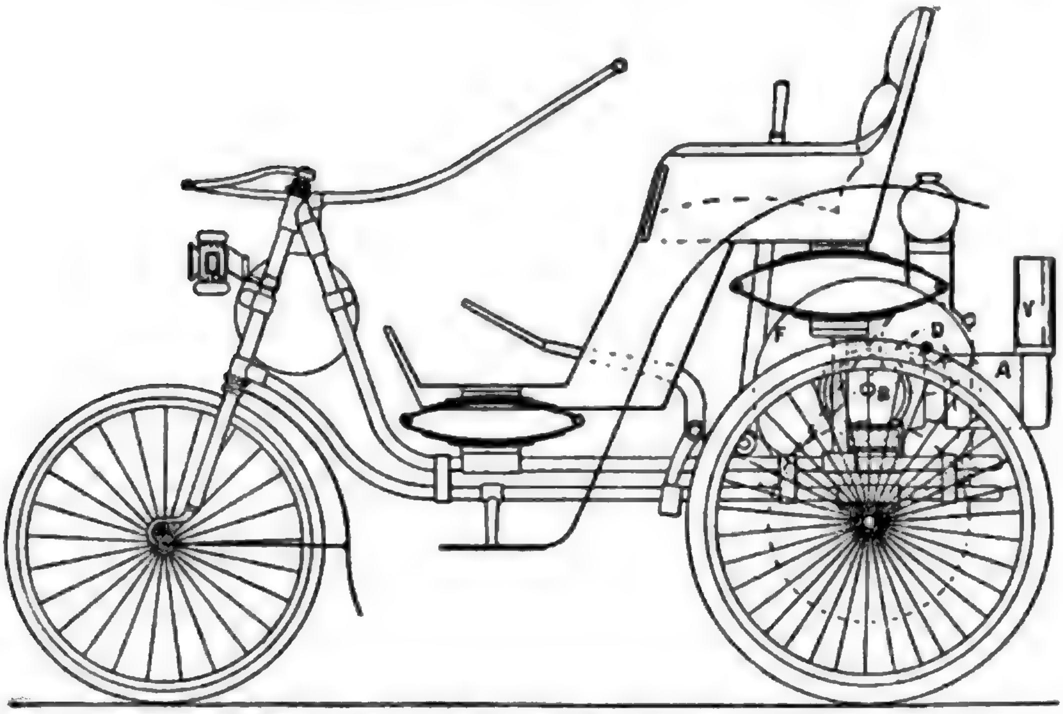
PETTER'S DOG CART, (PLAN).

M M', double cylinder motor ; N N', crank-shaft ; A A', forward high-speed belt pulleys ; B B', forward low-speed ; C C', reversing belt ; E, lever working jockey pulleys D D'. G, compensating motion ; F, reversing motion lever.

not been much modified lately. The Maison Parisienne sent a wagonette driven by a double-cylinder motor, the cylinders being on opposite sides of the crankshaft, but connected to two cranks at ninety degrees, so that, although not in line, they nearly balanced each other in the main direction. This motor ran very steadily, and the carriage was very quiet when standing with the motor running; it is, however, rather a heavy carriage. M. Bollée uses a double cylinder motor for his new carriages, and Leon Bollée would probably have distanced the Dion steam brake on July 24 but for the breakage, already mentioned, of a small rocking lever which opened the two exhaust valves alternately. This breakage incident suggests a reference to a mistake of common occurrence in the design of the small pieces having a high-speed rocking or angular movement,—namely, making them light because the work they have to perform is apparently light. A rocking lever may have to push a valve stem against the resistance of, say, a five-pound spring of an engine running at seven hundred revolutions per minute. It has to overcome this resistance in perhaps one-fortieth of the period of one piston stroke, or in about one-nine-hundredth of a second, and, if it works two valves of a double-cylinder engine, it does this seven hundred times a minute, and is jerked backward and forward fourteen hundred times. It is obvious without any calculation, therefore, that such a piece needs an enormous amount of strength.

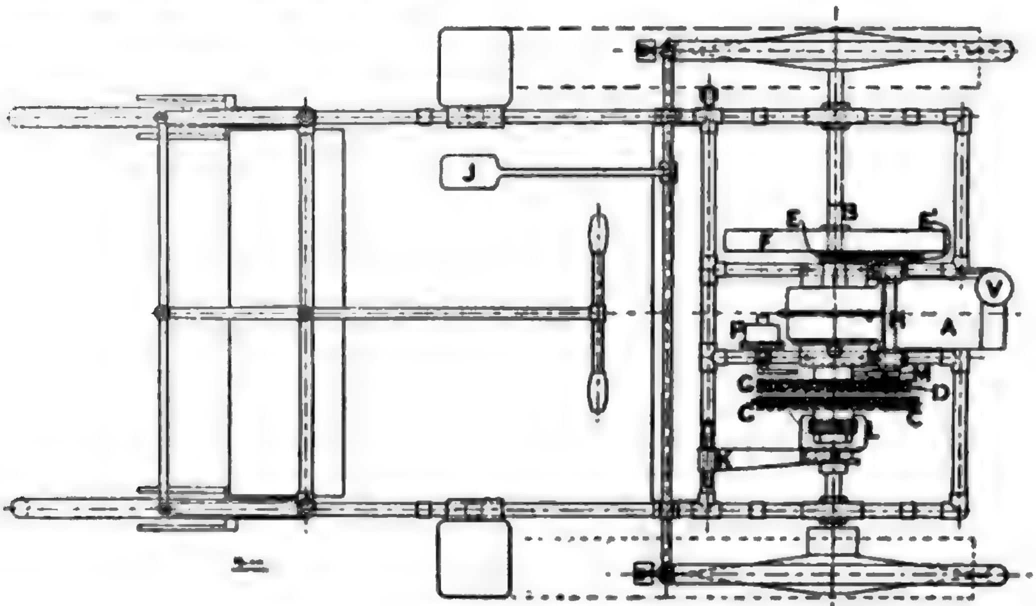
The vertical cylinder engine offers advantages which are considerable when the engine is mounted on the forecarriage, as is the Daimler, or Daimler-Phoenix, in the Panhard & Levassor carriages. It is easily accessible on three sides, and might be made to cause less vibration of the carriage when standing by complete balancing of forces in the vertical direction, leaving the consequent out-of-balance in a horizontal direction to be dealt with in another way. The four-cylinder engine of the Mors motor has advantages as to reduction of vibration, but it is desirable to lessen the number of parts.

In England one of the objections most strongly urged against the motor car is the smell from the products of combustion or from the heated mineral spirit. On this subject it must be noted that most of the makers, though not those who have made the largest number (if the Dion tricycles are omitted), use carbureters. By this means the chances of incomplete combustion and the heating and exhaust of unconsumed charges of oil are avoided, only a vapor charge ever passing to the cylinder or to the passages between carbureter and cylinder. This, no doubt, offers an explanation of the fact that very little smell is ever noticeable with the carriages or the Dion tricycles fitted in this way. However good the governing or the oil cut-



ROOTS & VENABLES KEROSENE MOTOR CARRIAGE.

out of a motor using the oil direct, there must be occasional remnants of charges or excess, when frequent stopping and starting are necessary. The automatic induction spray-making device of the Daimler-Meybach comes probably the nearest to a satisfactory means of dispensing with the carbureter, and this is adopted in England with results which satisfy every one except the most exacting. A different device is adopted in a promising light motor carriage by Duryea, but practical tests are yet wanted.



ROOTS & VENABLES KEROSENE MOTOR CARRIAGE.
A, engine cylinder; V, vaporizer; C C', driving chains; E, valve gear chains.

Only two makers—namely, Roots & Venables, of London, and Petter & Boll, of Yeovil—have so far attempted with any success to use motors worked with kerosene or high-gravity and high-flash-point oils. The difficulties as to vaporization, starting, and smell not only of exhaust products, but of partly-burned charges during stopping and starting, are much increased, and the success is of a very qualified character. One of the two makers referred to, both being English, prefers the mineral spirit motor.

Most of the large number of vehicles shown in Dieppe on July 24 and 25 were fitted with wood wheels, all having rubber tires and many having pneumatic tires. The limit of weight for pneumatic tires has probably not been reached, but experience so far seems to show that, for the high speeds frequently run in France, the limit is soon reached, and four hundred pounds per wheel is perhaps the maximum economical load even at moderate speeds. The Michelin tires used in France seem to stand well, except as to the cutting, which increases rapidly with increase of speed above eight miles an hour. Solid rubber will cut at least as much, but the effect is not so serious. The weight per wheel on rubber tires of any kind for high speeds is an important matter, for no pleasure-carriage can be considered satisfactory unless on rubber tires.

Iron-spoke or cycle wheels are used only by one eminent firm,—namely, Peugeot Frères,—the general opinion being in favor of wood. This is largely based on experience as to the durability of the wheels and their tires, but it is partly due to the facility the wood wheel spokes afford for the attachment of chain rings. For all vehicles, however, up to perhaps two tons' weight, the wood wheel will continue to offer the advantages of strength and a useful amount of elastic flexibility.

The question of relative economy of the different oil motors can hardly be said to have received much consideration. The cost per mile of running a carriage carrying four is so small that a little more or less is of no importance. Taking average roads, the consumption is not more than three or four pints per hour, and in this time twelve miles will have been easily run, so that the maximum cost per passenger per mile will be under a half-penny.

It is possible that within a year the industry, which is a real one in France, though limited to a very few makers yet, will be a greater one in the United States and the United Kingdom, but it will find most support first in the construction of business vehicles, such as vans and lurries.

THE EXTENDING USE OF GAS IN INDUSTRIAL OPERATIONS.

By Frederick H. Shelton.

THERE are about a thousand towns and cities in the United States wherein a total of approximately 60,000,000,000 cubic feet of illuminating gas is annually manufactured. This gas is used chiefly for lighting, largely for domestic cooking and heating, and to a moderate extent for power purposes. A very considerable proportion of it, however, is used—and to the very highest advantage—in place of coal, as fuel for purely mechanical and industrial purposes. That probably a similar volume of various kinds of gases other than illuminating gas is also made and used, wholly for industrial purposes, is not generally known, excepting to those whose business it is to be informed upon such matters.

It is my purpose to point out the great number and variety of uses to which gas is now applied in the arts and manufactures. Within the limits of a magazine article it is impossible to go into the details of the relative operating cost of gas as compared with other fuels, or of the exact nature of all these increasing applications. A bare enumeration of the principal uses may, however, attract the attention of consumers of hard fuel and lead them to appreciate more fully the advantages of gas fuel.

In the main heat has hitherto been secured from coal, which, while effective, is relatively cumbrous and inconvenient to handle. If coal could be conveyed as a fluid, from a central point, through suitable distributing pipes, to the various points of use, precisely as is water, steam, compressed air, oil, brine, or other fluids, the advantage, convenience, and desirability—disregarding cost for the present—would be obvious to every user. Assume this possibility, and that in many instances "fluid coal," so to speak, is cheaper than ordinary solid coal. From the industrial standpoint gas is simply fluid coal, or fluid fuel. Its use saves time, increases output, betters the quality of goods, eliminates ashes and heavy stoking labor, enhances convenience, and decreases expense. Small wonder, then, that it is extensively used and that such use is constantly increasing.

As popularly understood, "gas" is an invisible fluid served from pipes, which in burning gives off both light and heat. There are, however, several well-defined kinds of commercial gas, differing widely in their characteristics and heating power. The principal

ones are: natural gas; illuminating or city gas; blue or fuel water gas; oil vapor in various forms; and producer gas. These five comprise all the gases used by manufacturers at large to any considerable extent for fuel. Typical analyses of these, exclusive of oil vapors, are as follows:

	Natural gas from Findlay, Ohio.	Illuminating gas. Samples exhibited at Gas Exposition, N. Y., February, 1897.		Blue or Fuel Water Gas.	Soft Coal (Taylor) Producer Gas.
		Water Gas.	Coal Gas.		
Hydrogen	2.18	32.7	48.1	50.9	12.00
Carbonic Oxid	.50	30.2	7.6	44.5	27.00
Carbonic Acid	.26	2.4	0.3	2.45	2.00
Marsh Gas	92.60	16.8	36.5	....	2.50
Illuminants	.31	14.4	4.3	....	.. . ..
Oxygen	.34	0.4	0.4	0.07	.. ..
Nitrogen	3.61	3.1	2.8	2.08	56.50

Commonly spoken of as gases, these are really only combinations—practically definite and constant—of certain other gases, such as hydrogen, carbonic oxid, marsh gas, etc., as may be noted. As these component gases have each a well-defined heating value, the calorific power of any mixture of them (such as one of the above tabulated commercial gases) is readily determined by finding the nature and proportions of the component gases, and then aggregating their heating values. For instance, marsh gas is theoretically one of the greatest heat-producing gases, and naturally gas, being principally composed of marsh gas, proves in practice to have the highest heating value of all commercial gases. It is obvious that the gas having the greatest heating-value is, other things being equal, the most useful as fuel in mechanical operations. For comparisons of heating values the British thermal or "heat unit"—"that quantity of heat that will raise the temperature of a pound of water one degree Fahrenheit"—is used. Natural gas has a value of about 1,100 heat units to the cubic foot.

Natural gas is thus mentioned in order that its great heating power may be noted in figures, in comparison with the artificial gases, of which more extended mention will be made, rather than merely to specify the uses to which it is applied. These uses, of natural gas, while many industrially, are only those to which other gases can be applied. To the mind of the writer, the substitution for hard fuel of natural gas, intensely rich, costing but little, and conveniently supplied under pressure is not a measure so progressive as to call for

special commendation. It is certainly nothing in comparison with the skill and invention necessary to successfully and economically make and supply an artificial gas that advantageously displaces solid fuels previously used. To note the success that has been achieved in the use of artificial gas fuel is the especial object of this paper.

Illuminating or "city" gas, as made by the water-gas process, is the nearest approach to natural gas, in calorific intensity, of any of the manufactured gases. Made by the decomposition of water, it is chiefly composed of hydrogen and carbonic oxid, both of which gases have a high heat-unit value. When these are enriched by petroleum vapors to form an illuminating gas of 25 to 30 c. p., the resulting compound has an aggregate heat-unit value of about 725 to 760 per cubic foot. This, the best commercial gas that man can make, is yet, it will be noted, but two-thirds as rich in heating power as natural gas, which so far man has been unable to reproduce on any commercial lines. Illuminating gas, as made by the coal-gas process, is gas distilled from rich bituminous coals in retorts, and is composed principally of hydrogen and marsh gas. As served to the public, its heat-value is about 630. This carburetted hydrogen, however, whether made by the coal-gas or the water-gas process, is primarily made to give light. Richly laden with hydro-carbons and illuminants, its manufacture, purification, and distribution are expensive, and it cannot be sold by gas companies at a figure low enough to warrant its general use for heating in mechanical or industrial operations, except where the cost of the heat involved in an operation is but a small proprotion of the total cost. Its use is practically limited to light operations, where quality and convenience rather than volume of heat are essential. As the variety and number of such operations are very great, an enormous actual amount of city gas is, after all, used in commercial pursuits. One of the simplest of these applications is heating air. In ventilation a current of air may be conveniently induced by burning city gas in a flue. In dyers' and cleaners' drying-rooms, in tobacco-seasoning-rooms, in drying druggists' preparations, in the warming of lithographers' stones, etc., where a gentle heat is required, city gas is often the agent employed. The ripening of bananas by heat from city gas is common in the fruit trade. Equally common uses are the warming of liquids and melting of metals. In drug and grocery houses gas is used for the heating of vats, kettles, etc. Plumbers so use it in the shop for melting lead and solder. In large printing-houses it is used for keeping type-metal liquid in linotype machines, and for melting gelatin for ink-rollers, etc. In bottling works caustic solutions for cleaning bottles are kept hot by gas. The heating of irons is a common use. Both hand-irons and the rolls

of power irons are warmed by gas in laundries. Branding plates, irons for marking boxes or for stamping corks, and polishing irons in various trades are conveniently heated by gas. In the more strictly mechanical operations, hard soldering or brazing with the blow-pipe is very extensively done with gas. In the jewelry and silver ware working cities, of which Providence is typical, no mean proportion of the gas company's output is used in the shops for the soldering, tempering, case-hardening, and annealing small tools, dies, cutters, etc., and in the hundred and one small operations requiring heat. In other directions the uses of city gas seem endless. Dentists use gas in bunsen burners for warming and for softening cavity fillings. Express companies use it for melting sealing wax—an apparently trivial, yet strictly typical, instance of its convenience. Gas-fired ovens for firing decorated china are common. The metallurgist uses gas in assaying. Small tools, springs, and scores of other metal objects are made by gas heat. Hat factories use it in working felt, and shoe factories are large consumers. The filaments of incandescent electric lamps are baked by city gas in some instances. Bakers, confectioners, and restaurant-keepers constantly use it in their industries. Bicycle-makers use it for liquifying japans and enamels, and for brazing, annealing, hardening, etc. And so the list might be extended *ad infinitum*.

One important use is in water-distilling equipments for private houses. The increasing demand for pure drinking water has brought into the market gas heated stills for this purpose.

"Blue" or "Fuel water gas," or uncarburetted hydrogen, is the gas made in the first step of the manufacture of illuminating water gas. Composed almost entirely of hydrogen and carbonic oxid, it burns with a clear, blue, smokeless flame, and has a heating value of about 300 to the cubic foot. For mechanical purposes the gas is excellent, and it is simply and cheaply made. Commercially, however, the efforts to make and distribute it to the public at large for heating and industrial purposes have been unsuccessful. The reason is that, while "blue gas" is cheaper to make, its distribution costs as much as that of city gas, and, with its heating value but half or less (owing to the omission of the rich hydrocarbons or oil vapors), it has had to be sold at prices that have not repaid the makers. Even when sold at but half of the price of city gas, it proves, on the whole, to be still as costly *per heat unit*, and is, therefore, limited, like illuminating gas, to small operations. The plant for making it, however, is comparatively simple, and in numerous cases manufacturers who could not afford to buy either city or blue gas of another have yet found it practicable and economical to put in individual plants to make their own supply, thus saving the cost of distribution, and management, and the

profit. They thus obtain a gas of good heating value, clean and complete in combustion, easily piped and applied, and low in cost. For practically all the industrial purposes for which city gas is used, and kindred ones where small or moderate volumes of heat are required, it gives satisfaction mechanically, and often secures a marked economy over hard fuels. Many private plants are using this gas. Probably its most typical use is in factories where metal-working in many small forges is conducted upon a large scale, as in cutlery works, for which purpose it is an ideal fuel, vastly superior to coal. With coal there is the liability of unevenness of fire,—causing irregularity of goods and loss of time; with gas, there are no ashes to handle, and if the forges or furnaces are lighted half an hour before starting up, all will be at proper heat and continue so throughout the day. The work per forge or man is increased; time is economized, and "seconds" are decreased; cost is lessened, and the quality of the product usually bettered. In such work the gas is principally used in ovens or furnaces, which are simply fire brick-lined iron boxes, mounted on stands of convenient height, for drop forging, annealing, tempering and hardening, case-hardening, die making, etc. Blue water gas has also been used for years in the largest saw and file works in the country, and particularly in watch works. In the latter it has proven peculiarly suitable for delicate work, such as the annealing and tempering of fine springs, the enameling of dials, the melting of gold, silver, and platinum, fine blow-pipe work, etc. An interesting instance of the perfect suitability of gas fuel for many specific and unusual purposes in industrial operations is the use of blue water gas in one of the large New England bleacheries for singing the nap from cotton cloth. The old way involved the use of a heavy copper cylinder, revolving over a bed of coals that kept it hot. The web of cloth was rapidly moved over it, from one roller to another, in such a way as to graze the hot copper roll, tangentially. The momentary contact burned off the nap, but was also liable to burn holes in the cloth by fuel specks carried up, etc. The copper rolls were expensive, and warped and cracked in use, involving frequent re surfacing. The substitution of gas has made a perfect arrangement. In place of the copper roll, a finely-perforated gas pipe is now used; a row of minute gas jets supplies the requisite line of flame for singing the passing cloth, and the cumbrous coal bed and cylinder are things of the past.

Blue or fuel water gas has also been considerably used in foundries, iron and steel and glass works, etc., for drying cores and flasks, plate welding and reheating, crucible melting and other purposes. Such industries, however, tend towards the use of large quantities of heat,

and, while mechanically the work may be well done, economically it approaches the conditions wherein producer gas may be the cheaper to use. For drop or trip hammer forging, or other small high-temperature forge or furnace work—in rivet, rod and nail machines, in pipe bending and all operations of similar magnitude, blue gas is at its best.

The use of "oil gas" or some form thereof, owing to the cheapness of petroleum and naphthas, has in recent years made very considerable progress in the arts. The term is elastic. The true oil gas, made from petroleum vaporized in retorts by heat, is a chemically-fixed illuminating gas of very high candle power, with heating value unnecessarily good, and too expensive for mechanical operations. As ordinarily understood, "oil gas" is merely a mechanical mixture of air with oil vapor. A current of air is passed over or through suitable volatile oils, picking up so much vapor that the transportable mixture will burn with a moderate light and high heating effect. The Springfield gas machine for lighting isolated country houses is an old, though perfect, type of this. The "gasoline gas" or "greased air" product, as so made and popularly named, has practically all the characteristics and advantages of a gas, and for convenience sake is so designated. Apparatus for making it has been so perfected of recent years by the use of proper mechanical devices for ensuring the uniformity and reliability of the product that to all intents and purposes such apparatus has become the equivalent of individual factory gas works suitable for affording a fluid fuel-supply that will in many cases do the work done by natural, city, or blue gas, and with equal satisfaction and economy. Many such plants have been installed, particularly by metal-working establishments, isolated from the use of the so-called regular, or true, gases. While for a trifling amount of heat it would not pay to install a plant for its manufacture, and for large operations the cost of any form of oil gas would exceed the cost of producer gas, there is yet an enormous field of medium mechanical operations for which it is suitable. Those applications already mentioned, involving high-temperature work on a small scale, are representative. The manufacture of sewing machines and bicycles involves many specific applications. Dial and enamelled novelties, and gun work, where drop forgings are a principal feature are other specific instances. Other applications are the manufacture of rouges and polishing compositions; the melting of copper in brass foundries; the manufacture of dentists' tools and of artificial teeth; muffle work; assaying and refining gold and silver; "sweep reducers" melting; and blow-pipe work.

The heating value of the various oil gases differs widely, depending largely upon the design and efficiency of the producing apparatus.

As made from naphtha on a high-grade, typical, modern machine, its value is about 300 heat units per cubic foot, or about the same as that of blue water gas.

"Producer gas," by far the lowest in heating value of all commercial gases, presents a great contrast between its apparent relative worthlessness as compared with other gases, and its actual value for magnificent fuel economies in the largest manufacturing establishments, where its virtues are known and utilized. As ordinarily made, it has but one-fifth or one-sixth the heating value of city gas, or but 120 to 135 heat units per foot. More than one-half of it is incombustible nitrogen. It is utterly useless for illumination. It is so dull and inert that it cannot be easily lighted or burned if it has become cooled and lost the original sensible heat of the gas producer. It cannot be used in small quantities, or conveyed through small wrought-iron pipes, or be piped around a town like other gases; and yet, despite all these apparent drawbacks, it is so cheaply and simply made, and so wonderfully effective when properly applied, that it has become the standard and only fuel in numerous industrial operations of the highest importance. These operations are at times spectacular, and always interesting. Limitations to the use of producer gas are that it must be used as made, and on a relatively large scale, and at a point practically adjacent to the place of manufacture. These limitations are not objectionable in large manufacturing plants, and many, by installing producer gas, have practically secured all the advantages of cheap natural gas. In competition with rivals in the natural-gas field, the ability thus to secure so cheap a gas fuel is often a point of extreme importance. Producer gas, made up of carbonic oxid, hydrogen and nitrogen, is merely the blue gas of incomplete combustion often seen hovering over the top of domestic furnace fires. It is purposely made on a large scale from either buckwheat anthracite or cheap slack bituminous coals. Burned as it comes from the producer, it is so low in heating energy that it cannot be so used, except where moderate furnace heats are sufficient. By preheating the air used for combustion, however, by some system of recuperation, increased temperature can be secured; and, if, by a full system of regeneration, the incoming gas and air are both preheated, as high a furnace temperature can be obtained as may be necessary for almost any kind of work. In the latter cases, moreover, for a given amount of work the amount of coal necessary, converted into and used as producer gas, is often but a half or a third that which would have to be used if directly burned. For such reasons it is by far the cheapest fuel, where large quantities of heat and white-hot temperatures are required, as, for instance, in steel works. For years it has been a standard part of such plants for firing

open-hearth furnaces, the heating of slabs and ingots, the melting of steel, etc. Glass manufacturers have also made most extensive use of it in both crucible and tank furnaces for melting purposes. That it is sufficiently efficient in this work, one can well believe when standing before a 60-foot furnace of molten glass, kept seething and surging under the radiant heat from a torrent of producer gas playing over it. In copper- and silver-mining districts,—notably in Montana,—for smelting and ore-roasting, producer gas is largely used with especially marked success as regards evenness of temperatures and economy. The same is true for iron, zinc and other ore roasting. The modern method of steel making requires the reduction of the 2½ per cent. of sulphur often present in the ore down to about ½ per cent., before going to the smelting furnaces. The process consists of driving out the moisture by roasting, and producer gas is now practically the only economical way of accomplishing it. In the firing of pottery, terra-cotta, and brick kilns, producer gas is also extensively used. In the char houses of sugar refineries, for the making of animal charcoal, it is becoming a staple fuel. In annealing furnaces in the manufacture of steel rope and malleable castings, and in brass and copper works, it is used in numerous instances. In city gas works it is often employed for firing the retorts that distill coal gas. In illuminating water-gas manufacture it is used for heating the chambers necessary to fix and make permanent the petroleum vapors used for enriching. For the manufacture of enamelled iron bath-tubs, "granite" and other enamelled iron ware, it is peculiarly adapted, giving a cheap and uniform heat for firing the muffle ovens which contain the goods.

In the Solvay Process works near Syracuse, and in other similar chemical establishments involving large operations or reductions by heat, it is used extensively. In short, wherever heat is required on a large scale, producer gas is generally the cheapest of all fuel as well as wonderfully effective and convenient.

One of its most interesting special applications is the tempering of steel guns at the Bethlehem Iron Works, South Bethlehem, Penn. The gun is hung within a vertical furnace, and upon it from all sides numerous jets of producer gas play, until the right temperature is reached. The gun is then transferred to an adjacent oil bath, plunged within, cooled, and tempered, precisely as a blacksmith tempers a fine tool. When it is stated that some of these guns weigh twenty five tons each (forty-ton ones are in prospect) and are sixty feet in length, and that both the furnace and the oil tank resemble in size the water tower of a small town, the magnitude of this industrial operation of tempering by gas may be realized.

Enough has been said to show that gas, whether of one kind or

another, is used most extensively for industrial purposes, and that its use is evidently a factor of the highest importance to progressive manufacturers alive to the necessity of securing the greatest economy and all possible advantages in their fuel operations. And yet, extensively as it is used, and constantly increasing as its uses are, it is the opinion of the writer that the number of plants in which gas is so used does not constitute one-quarter of the number wherein it can, and ultimately will, be adopted to advantage. Whether it should be adopted or not by manufacturers not yet using it, need not be a matter of vague opinion; it is a matter susceptible of proof from practically exact figures. Hard fuel for any given heating operation now costs a certain amount. A given net amount of heating effect is secured from it, which can be closely calculated. The comparative cost of an equivalent net amount of heat secured from any one of the several commercial artificial gases mentioned is a matter of comparatively easy figuring to any one familiar with the nature of the work, the cost of the gas or gas-making materials, and the relative heating values and characteristics of the several gases. A manufacturer paying large sums per year for hard fuel who has not employed an expert to determine whether illuminating, blue water, oil, or producer gas can advantageously displace that hard fuel is certainly running a large risk of conducting his business under a handicap of unnecessary fuel expense, compared with the possible lower cost of gas. In a surprising number of cases the figures will show that economy can be secured by intelligently substituting one of the gases mentioned, to say nothing of an increased amount of product, a better grade of work, and other incidental advantages almost invariably secured.

The Mole Antonelliana.

THIS is said to be "the tallest structure" and the "most venturesome piece of construction in the world." It forms the subject of an interesting illustrated and technical description in the *Journal of the Association of Engineering Societies* for May. The paper was read before the Technical Society of the Pacific Coast, February 5, by Mr. G. W. Percy. "The peculiarity of this remarkable work consists, principally, in its light, elegant construction, with common bricks and lime mortar, whereby a small quantity of material, and that of the most common kind, is employed to enclose a large building and carry it with safety and stability to the unprecedented height of 538 feet above the ground." Although the mortar is of the common kind, unusual care appears to have been taken in its preparation; we are told that it was made from lime slaked and buried in pits for a year or more before use. A proper admixture of sharp sand is employed in the mortar, and no cement whatever is used in the work. "The actual load on most of the supporting members is about fifteen tons per square foot, which must be largely increased at times by wind pressure. The structure is named after the architect who designed it and personally supervised its erection,—Professor Antonelli, of Novara. The building was constructed for the Israelitish University Society of Turin, and in a competition instituted in the year 1862, in which many plans were submitted by Italian architects, the design of Professor Antonelli was accepted. The design was to produce "an imposing structure, which would serve at once as a grand synagogue, college, and administration building." For the details of the design and construction the reader may consult Mr. Percy's article. One of the principal points of interest in the structure is the combination of cupola and spire, which beginning at a height of 275 feet from the ground, rises 268 feet further, and superimposes a weight of about 550 tons upon the dome proper. It is hardly necessary to add to the above that the design of such a structure demanded the highest degree of skill; the fact that it is regarded as safe by competent authorities is sufficient evidence of the competence of its designer.

The General Government Fostering Good Roads.

IN an elaborate article in *Brick* (July 15) the subject of good roads is treated: first, historically, beginning with the ancient Roman roads and their builders; second, from an engineering standpoint; and, lastly, in its present aspects in the United States. What the general government is doing to further good-road building is also set forth at considerable length, in a quotation from a letter written by W. E. Curtis to the *Chicago Record*. The department of agriculture has directed General Roy Stone, chief of the bureau of good roads, to construct and exhibit an example of a steel road at the Nashville Exposition. The use of this material for roads in regions where stone and gravel are scarce and where the soil is deep and sticky will, in the opinion of Secretary Wilson, be "the easiest solution of the good road problem" for such localities. At present prices these steel roads can be cheaply constructed. Flat, or slightly trough-shaped, bars of steel are to be used as supports for the wheels of vehicles, and, to prevent the slipping of horses, the rails will be transversely indented sufficiently to afford a foothold for the calks of horseshoes without materially affecting the smoothness of the surface for the wheeltreads. The joints of the flat bars, or rails, will be made strong enough to prevent them from giving way under use, and thus forming depressions. While forty pounds per ton is the average required to pull a load on a level macadam road, it is claimed that eight pounds will do this

work on a steel road. In this respect, however, a good brick road can be scarcely inferior to steel. It is believed that a good brick road will outlast a steel road. Another way in which the government is helping on the cause of good roads is by using the agricultural experiment stations as sources of instruction in road-building to the public at large. On this point Mr. Curtis says: "The limited funds at command have not encouraged any practical work in this direction, but coöperation has now been established by the director of roads, under which the manufacturers of road machinery furnish the necessary plant free of charge, the county or city authorities provide the material and the labor of men and teams, and the government furnishes an engineer to oversee the work and instruct students and visitors, and pay for one or two skilled operators for the machines. In this way a very slight outlay of public funds accomplishes a large amount of instructive work." Experiments with brick roads are already in progress in some of the western States. At Monmouth, in central Illinois, a road of vitrified brick set on edge in a single course on a bed of sand between oak plank curbs is now undergoing probation, and is regarded with favor. Brick trackways, with intervening gravel paths for horses, have been proposed. Where macadam roads are practicable, and under the most favorable conditions,—*i. e.*, where laborers can be obtained for seventy-five cents per day, where fuel for steam power is cheap, and where suitable road metal is close at hand,—they may be constructed and bridged for $100 per mile for each foot of width. Thus a road thirty feet wide would cost 3,000 per mile. Good gravel roads cost from $1,000 to $2,000 per mile. The material for the heaviest class of steel roads costs, at present prices, $3,500 per mile; for lightest steel roads the cost of material is estimated at $1,000. For long lines of the heavier class of roads, it is thought, the steel will ultimately cost about $2,000 per mile. Brick for road-building will cost more per mile than steel for tramways, but, taking the intermediate path for animals and the side ways into account,—for these must be well built and maintained also,—we are inclined to agree with *Brick* that a road paved from curb to curb with vitrified brick is, in proportion to its cost, the best road known to modern engineering.

Electric Production of Sodium Peroxid.

THE changes wrought by the use of electrical methods in some of the chemical and metallurgical industries are destined, we think, to be ultimately as sweeping as the changes in the mechanical arts brought about by the application of electrical machinery to the transmission of power, etc. The *Electrical Engineer* (June 23) gives an outline of the electrical equipment and installation of the Niagara Electro-Chemical Company, with illustrations of its three rotary transformers of 175-kilowatt capacity, running at five hundred revolutions per minute, which form part of the very complete outfit. The process of making sodium peroxid is extremely simple. The metallic sodium is first electrolytically obtained from molten caustic soda. The electric current is run from the switchboard to, and in series through, the pots in the pot-room, and the metallic sodium is cast into the form of bricks. "The sodium is put in regulated quantities into dishes which travel through a long tube fixed in a furnace. Dry air in regulated quantities is then passed through the tube, which is kept at a certain temperature, and the sodium is oxidized to peroxid. The peroxid comes out as a beautiful canary-colored substance, which is immediately sent to the grinding-room to be ground and packed. It will undoubtedly seem strange to some that a metal, like sodium, which a few years ago was barely seen outside of the laboratory, should be made in such quantities, be handled with such ease, and be converted into a peroxid which gradually, but surely, appears to be taking the place of barium peroxid. Both are used in the manufacture of hydrogen peroxid solution. Until recently the bleacher has been obliged to buy his peroxid of hydrogen in the form of a solution, which is bulky and likely to lose its strength; it is also difficult to keep

with it a bath of uniform strength. In peroxid of sodium, however, the bleacher has a substance which, it is said, contains twelve times as much oxygen available for bleaching as the ordinary ten-volume hydrogen peroxid solution, and which can be kept an indefinite time." The process of manufacture is continuous, employing fifty men, divided into two shifts of twenty-five each.

The Sault Ste. Marie Canal.

THE report of this canal for the navigation year 1896 shows that the total value of all freight passing into and out of Lake Superior in 1895 amounted to $159,557,129. In 1896, notwithstanding a general depression in the value of commodities, the total value of the freight passing through the canal was $195,557,129. A remarkable feature is the reduction in freights. In 1886 the freight was 2.3 mills per ton per mile. This has been reduced to 0.99 mills per ton per mile, or only about one-fifth of the freight rates now charged on the most economically-managed railways. There is a continual growth in the size of cargoes, 5,000 to 5,250 tons now being no longer exceptional. It is only a few years since a vessel carrying 2,500 tons was considered enormous for upper lake traffic. The *Boston Journal of Commerce* (June 19), commenting upon the statistics given in the report named, says: "The number of vessels plying to the port of New York or elsewhere in the ocean service, and carrying more than these ships of the inland lakes, is very small indeed, so far as bottoms owned by Americans are concerned, and, with the single exception of one line of ocean passenger ships, there is nothing to equal these newest lake fleets. While these ships are very differently modelled from those on salt water, they are every whit as substantial, and receive the highest ratings from Lloyds and other bureaus. Indeed, many of the notable recent advances in marine architecture have originated on the American lakes." It is claimed that the first quadruple-expansion engines used in the merchant marine were placed in the two express passenger steamships of the Great Northern railway, "which are scheduled for shuttle-like runs between Duluth and Buffalo at a sustained speed of twenty miles an hour, week after week." It is also claimed that the first two tubulous steam generators used in the merchant service were employed on the lakes. The western ship-builders have also devised for the peculiarities of lake service new models of steel construction for hulls, "and the channel system, in use at most lake yards for the larger ships, is supposed to be ahead of any other method for strength and saving." The improvements for handling cargo have always been enormous. One thousand bushels a minute is an ordinary rate in loading ships with grain. Ore is placed on vessels at the rate of one thousand tons an hour. Coal is shipped by the carload, the cars being hoisted and dumped into the holds of the vessels. The journal quoted thinks it not improbable that fifty million tons of freight will be moved in all the inland lakes of the chain this year.

Comparative Fusibility of Foundry Metals.

THIS subject, lying at the very foundation of the knowledge of metal mixtures in foundry work, was ably treated by Mr. Thos. D. West in a paper read before the Pittsburg Foundrymen's Association (June 28), and printed in *The Iron Trade Review* (July 1). Mr. West, as is usual with him, begins at the beginning of the subject, and points out "how easily a formulated mixture can be prevented from giving calculated results by one metal having a lower fusing-point than another when charged into a cupola." Not only to the founder of heavy castings, but to the manufacturer of light castings, this is important. Mr. West's paper gives an account of an experimental research made by him to ascertain the effects of "different combinations of metalloids upon the fusing-point of iron." Failing to find suitable appliances for carrying out such an investigation, he devised a cheap cupola, which answered the purpose. A portion of the paper is taken up with an illustrated description of this apparatus and its operation, for which the original paper must be

sought. We may say, however, that it is designed to provide for comparative tests (the assumption being that the metal which comes down first has the lower fusing-point), for separate discharge which prevents the commingling of one metal with another on the sand bed of the cupola, and for so regulating the blast—including a center blast—as to obtain uniformity of heat in all parts of the cupola area. In the use of the cupola for determination of comparative fusibilities eight men are needed: "a time-keeper; a man to charge on fuel and poke it down, so as to preserve a solid fire until the iron is about half down; one at each tap hole, to keep it open, that the metal may flow freely; and, if the metal is to be caught in molds, two men on each side to take away the filled molds and replace empty ones." Passing over a statement of the different useful applications to which such a cupola is adapted in foundry study and practical work, we come to the results of experiments upon fusibility made previous to the date of the reading of the paper. The investigation is only in its first stage, but, at the special request of the secretary of the association, Mr. West consented to make known the effect of low silicon and high sulphur upon the fusibility of iron, as compared with the carbon and iron closely constant. Other papers promised will deal with results of more extended investigations. We cannot here reprint the tabulated data of comparative fusing tests of high and low silicon and high and low sulphur irons, but we quote Mr. West's remarks upon the tables. After stating that the drillings for analysis were all taken from the blocks as they came from the first casts of the original pig or scrap metal, he says: "In all the 'heats' the hard iron is seen to come down first,—excepting one case, which is found in heat No. 6,—and that the flow of hard iron ended soonest in all the heats. Thus, as far as these tests go, they show that hard iron will melt faster than soft iron. While I desire to reserve for my next paper any comments as to cause and effect in relation to the chemical composition of these irons, I will say that the irons used correspond in their analysis to irons employed in general founding. . . . I am of the opinion that we can have a combination of the metalloids wherein the softer iron would be the first to melt. . . . And I believe the day is coming when we shall consider reliable data upon the comparative fusibility of our irons to be often of as much value as a knowledge of their chemical constituency." Mr. West outlines further research contemplated by him in this new line of investigation.

Sewage-Filtering for Small Towns.

ENGINEERS who are engaged in designing filter beds of very moderate capacity may gain some useful hints from an illustrated detailed description of filter beds designed by Charles W. Leavitt and constructed at Essex Fells, N. J., which is printed in *The Engineering Record* (July 3). "These filter beds are used to dispose of the sewage (about 20,000 gallons daily) of an improved residence district. They have been substituted for a system in use several years, constructed at small cost ($2,000), and in which the liquid was conveyed from a receiving tank,—where about half its solid matter was separated,—through five hundred feet of jointed pipe, discharging it finally into a mass of broken stone buried in the natural gravel. . . . As it was believed that this arrangement would eventually become clogged up by the accumulation of slime, sediment, etc., it was decided to retain the old outlet in case of very severe winter weather, and construct new beds for general use." This retention of the old system for use in case of emergency, while constructing new works for regular use, seems to be a wise provision in cases of this sort, answering the same purpose as the duplicate filter beds of larger and more costly installations. The additional filter beds cost only about $1,500, which will be recognized as a low figure for works of the capacity named, the pipe line and reservoir now used being sufficient for additional filter beds that will bring the capacity up to 40,000 gallons daily. This provision in the capacity of pipes and reservoir for increase of filter-bed seems also a judicious

proceeding in situations like this, where the increase in population is sure to be considerable, but impossible to estimate with any approach to accuracy. In these works the grading and construction of the filter beds cost $550, while the pipe line and reservoir cost $950. "The sewage now enters the receiving tank, passing from one chamber to the other through openings in the partition wall, deposits the coarser part of the solid material suspended in it, and, instead of flowing off as before, through a trench-pipe, it rises through a standpipe, and is discharged midway between the top and the bottom into an adjacent reservoir, which, when full, discharges through a syphon, thus intermittently flooding the filter beds, from which sub-drains convey the clear effluent to a small running stream. The reservoir has brick walls and a concrete bottom, and it is covered by a flat roof of 3-inch flag-stones laid on double rows of 3-inch rolled steel beams that are carried by steel cross-girders. When the sewage rises in the tank to the tops of the syphon (about once in 24 hours), the flow through its long leg (that is sealed by the back-water retained by the little dam in the bottom of the outlet chamber) exhausts the air and puts the syphon in action. This empties the reservoir in about 45 minutes. The carrier-pipe terminates in a distributing man-hole, where the sewage may be diverted into either of the two filter beds at will. The filter beds were made by simply removing the top soil and excavating and filling in the natural gravel bank only enough to make a level top service, and by building puddled side embankments."

Ratio of Grate Area, Heating Area, and Cylinder Volume.

UNDER the above title *The Railroad Gazette* (July 9) prints an extract from the report of the American Railway Master Mechanics' Association appointed to investigate and determine the ratio of heating surface and grate area to cylinder volume for passenger and freight engines, whether burning anthracite or bituminous coal, and also the ratio which should exist between the size of cylinder and the length of steam port. The report is extremely able, reflecting great credit upon the gentlemen who composed the committee. Forty years ago, a report of this high character from railway master mechanics would not have been obtainable. It marks a great advance, not only in scientific and practical railroading, but in the profession of mechanical engineering. All we can hope to do in reviewing a document of this length, which, with diagrams and formulæ, occupies nearly six closely-printed columns of the newspapers named, is to give an inkling of its importance, not only to locomotive designers and builders, but to constructors and designers of stationary and marine engines; for, though a locomotive differs in many respects from other types of steam engines, the principles underlying the conversion of heat into mechanical energy are the same in all. For instance, this index to the evaporative value of fuels is surely a collection of data worthy of a place in every engineer's notebook:

INDEX TO EVAPORATIVE VALUE OF FUELS.

No.	Location of mine.	Kind of fuel.	Ratio of heating surface to grate area.
1	Pennsylvania	Anthracite, large	45
2	"	" "	20
3	"	" fine	20
4	"	" "	20
5	"	Semi-bituminous	70
6	"	" "	84
7	Virginia	" "	66
8	"	" "	57
9	"	" "	49
10	Illinois	Bituminous	50
11	"	"	55
12	"	"	71

It is certainly safe to say that the ratios of heating surface to grate area for the best results in the generation of steam vary through a much wider range than is generally known to designers and constructors of boilers and portable engines. Heating engineers have often been at a loss to explain why such differences in results attend the use of the same boiler with different fuels. Of course, they have recognized the fact that these results had a close relation to the fuel, but, without the authoritative statement given in the tables, few of them would be prepared to believe that in a locomotive semi-bituminous coal of some grades requires four times as much grate area in

proportion to heating surface as some grades of anthracite. It does not follow that as great differences in ratios of grate area to heating surface would obtain in boiler furnaces, where natural draft is relied upon, as in most heating installations; but the figures in the table point to much wider differences than are recognized in practice. Here follows another useful set of data.

RATIO OF MAXIMUM ROTATIVE FORCE TO AVERAGE ROTATIVE FORCE AT VARIOUS CUT-OFFS.

Cut-Off Pressure	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1
100	1.52	1.31	1.17	1.09	1.10	1.17	1.19	1.20
200	1.47	1.30	1.11	1.09	1.12	1.16	1.19	1.20
Approx. Average	1 50	1.30	1.15	1.10	1.10	1.15	1.18	1.20

This table is made up for locomotives in which the connecting-rod is 9½ times the crank radius, or about 5 times the stroke; but it is stated that results with other lengths of connecting-rods show but little variation from those presented in the table. The point of maximum rotative force is found to be 15 degrees each side of the 45-degree point. The following conclusions were reached. The ratio of grate area in square feet to total cylinder volume in cubic feet, for simple passenger or freight locomotives, should not be less than 4 for large anthracite, 9 for small anthracite, and 3 for bituminous coal. The ratio of heating surface in square feet to total cylinder volume in cubic feet, for simple passenger and freight locomotives, should not be less than 180 for large anthracite, 200 for small anthracite, and 200 for bituminous coal. Formulæ for working out the proportion for compound locomotives are presented. The ratio of heating surface to grate area should not be less than 40 for large anthracite, 20 for small anthracite, and 60 for bituminous coal.

The proportions given for bituminous coal are also applicable to coke and fuel oil.

The ratio of the fire-box heating surface to total heating surface should be about 10 per cent.

The ratio of tube length to outside diameter should not be less than 70, and may be 90.

A Notable Institution.

THE Webb Academy and Home for Shipbuilders at Fordham, now included in New York city limits, is one of three existing institutions of its kind. Its founder, Mr. William H. Webb, once a prominent and successful ship-builder, amassed a handsome fortune, and still lives, in good health and unusual vigor, at eighty years of age, to enjoy the results of his labors. His life has been marked by industry, integrity, ability, and force of character, and in his old age he conceived and carried out the idea of the institution, which, under the title "A Ship-builder's Dual Monument," is described and illustrated in *Harper's Weekly* (July 10). The description of the institution is extended to include a brief biography of its worthy founder. We shall note here only a few of the facts relating to the institution, which, founded in 1890, occupies thirteen acres of elevated ground, and which, designed chiefly by Mr. Webb himself, has an imposing appearance when seen from a little distance. Doubtless professional architects might find something to criticise in this amateur design; but its general adaptation to the purposes of the institution cannot be questioned. These purposes are the establishment of a home in which "free and gratuitous aid, relief, and support to the aged, decrepit, invalid, indigent, or unfortunate men who, within the precincts of the United States, have been engaged in the craft of ship-carpentry, building of marine engines, or any part or section of the hulls of vessels or engines thereof, together with their lawful wives, will be furnished. Furthermore, to furnish any worthy young man, a native or citizen of the United States, who, after careful examination by the trustees, shall have proved himself competent and of good character, with a free and gratuitous education in the art and science of marine architecture and engineering, both theoretical and practical, and also teach him the craft of ship-carpentry, marine-engine building, and the allied trades, with free board and lodging, tools, engineering implements and materials while acquiring that education." The way in which these

purposes have been carried out honors equally the head and the heart of the founder. The building cost $600,000, and is endowed with $2,000,000, all the gift of this generous man. Its interior furnishing and outfit are of excellent quality throughout, and passenger and freight elevators afford easy access to all parts of the building. "On the third floor are the apartments of the guests and students, by which names Mr. Webb, with considerate delicacy, insists that the old and young who enjoy his bounty shall be known. The guests' apartments are double, for the accommodation of husband and wife, and are fitted up in a way that must seem luxurious to their occupants, who doubtless knew little genuine comfort in their active lives. Each room is furnished with a bureau, wardrobe, wash-stand, and drawers—all of highly-polished maple; the large double bed is of iron, painted white and gold; a carpet of pretty design covers the floor; and even the little ornamental scrap-basket has not been forgotten. The rooms of the students are furnished in similar manner, and all have an abundance of air and light. In one of the large and cheery round towers are the hospital, the convalescents' room, and the nurses' bed-rooms. Here are sick-beds, invalid-chairs, and all sorts of improved appliances for the ailing, while rooms have been provided for the friends of sick guests and students who may desire to have their friends with them when ill. Spacious bath-rooms fitted up with all conveniences are scattered about the dormitories, the building is heated by steam and lighted by electricity, and electric bells and speaking-tubes connect every room with the office of the superintendent." A staff of well-trained servants is maintained. The old people who have become the guests of the Home seem to be as happy as their benefactor intended them to be, and the educational department—the Academy—is filled with eager, earnest students, availing themselves of their splendid opportunity. A carpenter shop, a mold-room and drafting-room, and other facilities for learning the art of ship-building under able instructors, are provided. "All branches of ship-building are taught in the Academy, and the course covers from three to four years. Thus in a few years the government will have at its command in the alumni of the Webb Academy a numerous group of trained marine architects, who will prove a tower of strength in some unforeseen hour of need—a possibility which prompted Mr. Webb to lay the foundations of the academy with exceeding care upon the broadest lines." The good effects of this noble benefaction will become more pronounced as years and experience add to its working efficiency.

By-Products in Gas Manufacture.

THE mutual relations of the by-products of gas manufacture, not from a scientific standpoint, but from the economical and commercial point of view, were discussed at the recent Berlin meeting of the Society of German Gas and Water Engineers, by Dr. H. Bunte, of Karlsruhe. An abstract of a translation of this paper is printed in *American Manufacturer* (July 9). The use of gas-coke for domestic fuel is shown in this discussion to be increasing in Germany, and the association before which this paper was read has instituted a prize contest for the production of the best gas-coke stove. It has been found that by proper crushing, thus supplying coke of specific sizes, as is done with coals, the use of coke for domestic purposes has been much increased. The extension of the use of this fuel in the industrial arts was also urged, it being especially desirable in operations where soot and smoke are objectionable, as in large towns. Gas-coke is an essentially smokeless fuel, and its more extended use in cities ought to be encouraged in every way possible. Systematic endeavor to promote the greater popularity of the fuel, and to demonstrate to manufacturers its advantages, is urged upon the gas companies. But a substitution of coke for coal, as fuel for steam generation, requires alterations of grates and furnaces, and, unless as permanent and regular a supply of this fuel can be relied upon as is that of coal, it would be folly for a steam-user to change from one to the other. Pound for pound, coke is

also a less efficient fuel, containing fewer units of heat than the coal before its distillation in the retorts. Variations in the heating quality of cokes are small (at most, about five per cent.), and result principally from the greater or less quantity of ash contained in the fuel. As to cyanogen, which was once a valuable and profitable by-product, the large output of potassium cyanid which has been placed on the market has lowered the price to an unremunerative point. The demand for ammonia, in the form of sulphate, for agricultural uses seems practically unlimited, but the future of this article of commerce may yet be disastrously affected by the use of "*nitragine*," so called, which enables plants to draw their needed nitrogen from the atmosphere. This new departure in agriculture is looked upon with some anxiety by the manufacturers of ammonia (chiefly gas-works), though, so far, it has not seriously affected the trade in ammonia. The price, however, has suffered from the very large quantities of ammonium sulphate manufactured during the past five years. A considerable quantity of liquid anhydrous ammonia is now used in ammonia ice-machines, but this is not enough to much affect the general market-price of ammonium sulphate, or of such other ammonium salts as the gas-works find it inconvenient to make.

Magnetic Surveys.

THE great scientific and engineering value of magnetic observations in supplying needed data for engineering developments is emphasized in a short paper read by Mr. William S. Aldrich, C. E., before the annual meeting of the Association of Engineers of Virginia, and printed in *The Journal of the Association of Engineering Societies* for May. The influence and action of the engineering societies of the principal States and cities in encouraging and promoting such service by legislation are strongly urged and solicited. The magnetic elements to be determined by a magnetic survey are: (*a*) "the magnetic declination, or, as commonly called in surveying and marine work, the variation, of the compass,—measuring the horizontal angle between the true geographical and the magnetic meridians at any point;" (*b*) "the magnetic inclination or dip of the magnetic needle,—measuring the vertical angle in plane of magnetic meridian which the freely-suspended needle makes with the horizontal plane at that point;" (*c*) "the intensity of the earth's magnetic force at point of observation,—determined either (1) in its total intensity, or (2) by its horizontal component." A sufficient number of these observations, made at selected points, supply the necessary data for plotting on the map lines showing the characteristic features of the magnetic elements at the time of the observation,—to wit, isogonic lines, drawn through all points having the same magnetic declination or variation of the compass, isoclinic lines drawn through all points having the same magnetic inclination or dip of magnetic needle, and isodynamic lines drawn through all points having the same (1) total magnetic intensity or (2) horizontal component of the earth's magnetic force. Mr. Aldrich says that the most extensive and systematic work of this character has been inaugurated by Maryland. "Many of the early stations of the United States coast and geodetic survey have been reoccupied, and magnetic survey stations have been established at every county town throughout the State, making forty-three in all. There there is one station for about every two hundred and fifty square miles." The magnetic observations made in this State during the summer and autumn of 1896 resulted in the obtaining of data which, he asserts, will prove to be of immediate value to all surveyors and of "great scientific importance in connection with investigations connected with the location of the great rock masses in the State of Maryland." Without the data supplied by magnetic surveys, it is not possible to retrace old lines.

THE BRITISH PRESS

Artistic Electric Lighting.

IN an editorial on the numerous instances of incongruous and inartistic electric fittings in the *Electrical Engineer*, June 18, it is suggested that, when electric lights are to be introduced into previously-designed apartments, the designer of the decoration of such rooms should be consulted, or at least a person equally competent to design the electric-light fittings in accordance with the general design of the room itself. The point is illustrated by a reference to two notable instances, one of inartistic electric-lighting work, and one of the opposite type, the effect in the latter being singularly pleasant. Pictorial reproductions are given, which show that, with proper care and attention, a much more harmonious and satisfactory result can be obtained than is usual. The first instance cited,—namely, that of inartistic work,—in a room in the west end of London, "was one in which the artist and designer spent a great deal of time and trouble to produce a perfect specimen of an Empire drawing-room. A year or so later the supply mains came along, with the certain result that the electric light had to be installed. The work was entrusted to a firm of electrical engineers of very high standing in the profession, but who, doubtless, were more used to the foundry and erecting-shop than to the artistic adornment of a drawing-room. As a consequence, their client was allowed to select what took his fancy, and the result was the spoiling of the room, from an artistic point of view, by the supplying of fittings of the 'Benson' style,—fittings which in a modern 'Liberty' style of room would have looked perfectly in keeping, but which, under the circumstances, were most inartistic." A worse effect results in cases where the fittings have no sign of artistic treatment at all, which is the more common case. The making of electric fittings has got into the hands of the manufacturers of gas fittings. "Their idea of electric fittings is simply to turn their old patterns upside down, overlooking the fact that with gas fittings there is not much scope for artistic treatment, whereas with electric light its chief beauty is the easy manner in which it can be treated artistically." It is conceded, however, that the artistically designed and executed fittings are much more frequent now than they were a few years ago. The designing of such fittings is now sometimes done by the designers of the decorations of the room, in cases where elaborately-decorated rooms, in accordance with some special idea or scheme, are constructed. This method is the only one by which to avoid incongruities such as are above set forth.

Facts Relating to Fire-Damp.

MR. FREDERICK DELAFOND, chief engineer of the Belgian mines, has summarized for the inspector-general of mines and president of the French fire-damp commission the principal facts relating to fire-damp outbursts, as observed and recorded by engineers who have studied the subject in France and other countries. A translation of this summary, published originally in *Annales des Mines*, is contained in the *Colliery Guardian* (July 9). According to this summary, outbursts of fire-damp in Belgian mines have been confined to a small number of collieries, generally situated on the southern boundary of the coal fields. Of these collieries only a few disengage fire-damp. The top of the seam appears to exert no influence. Gas is disengaged from horizontally- and highly-inclined fissures of the same seam alike. Disturbances which have effected the seams exert a preponderating influence; only twelve occurred where the seams were regular. A sudden outburst is not generally indicated by any previous circumstance. Sometimes even the working place itself did not appear to give out any fire-damp before the outburst. A large number of instances of outbursts are cited to prove the absence of premonitory indications. Outbursts may occur successively in one and the same seam, at points near each other. This is proved

by a list of explosions, in which these successive outbursts took place. It appears that the taking out of the pillars from a mine operates to facilitate the disengagements. Out of one hundred and thirty-one outbursts, one hundred occurred when the pillars were being removed. A period of exploration and preparation is, therefore, more dangerous than that of actual coal-getting. The disengagements are rare at depths not exceeding three hundred meters, becoming more frequent and intense as the depth is increased. Means for preventing sudden outbursts are discussed, and the boreholes, which have been criticised as not giving sufficient warning, and as reducing the resistance of the working face, are commended. While the force of the criticism is admitted, it is held that, nevertheless, this means of preventing accidents should not be neglected. It is stated that M. Petit, chief engineer of the Saint Etienne collieries, expects to obtain, from methodical boring of advanced holes, valuable indications affecting the security of the mine. A method of prevention advocated by M. Roberti-Lintermans is diminished rapidity in advance in stalls and headings. While this precaution is commended, it is not always possible to apply it, and to restrict the rapidity of advance sufficiently to make it effective as a preventive measure. A third preventive measure consists in pushing forward the workings of a less fiery seam beyond those in the others. This method is commended whenever it is practicable, which is not always the case. M. Marsaut has used large mine shots, fired after the men have reached a place of safety. The effect of this explosion is to open compact measures and render them more or less permeable to fire-damp. This diminishes the pressure of the explosive gas, lessens the danger, and gives rise to blowers that reveal critical states. Measures for preserving the men from the consequence of sudden outbursts are the use of safety lamps and vertical air partitions, means for insuring the rapid evacuation of fire-damps, and the service of compressed air, in which air is discharged at about every thirty meters to within one hundred or two hundred meters from the working face. In the event of the workings becoming infested with gas, this distribution of air will allow the men to escape asphyxiation.

The Oxidation of Iron and Steel Structures.

IN an article by Mr. William Mackenzie, assistant engineer of the Intercolonial Railway, he describes, in *The Canadian Engineer* for July, under the title "Painting Metal Bridges," a series of tests or experiments (begun in 1895) upon the value of various paints as a protection to iron. He withholds the names of manufacturers, but gives his method of testing paints, and presents a general statement of facts which will interest civil engineers, architects, and builders. We herewith present a brief abstract of Mr. Mackenzie's article. Twenty-four new wrought-iron plates, each one foot square, were painted with two coats of different paints. Three of these were painted with ready-mixed paints; the rest were covered with paints of different kinds, each mixed with the same boiled linseed oil. The plates so prepared were exposed to the action of corrosive influences by suspending them to one of the chord eye-bars of a steel railroad bridge 1,900 feet long, which crosses a strait, or an arm of the sea, about thirty-five miles from the Atlantic ocean. Here the plates were exposed to the action of salt spray in rough weather and of salt air at all times. The situation appears to be a peculiarly trying one. Even a light north-east breeze causes spray to be dashed against the floor, and in storms spray is thrown up on the floor and across the bridge. Unprotected metal, of course, corrodes rapidly under such conditions. The bridge itself, built in 1890, requires very careful and constant attention, that defects in the painted surface may be remedied as they appear. This bridge was given a coat of iron-oxid paint in the shop, and another coat when erected. In 1892 it was found to be considerably rusted. Two more coats of the same kind of paint were then put upon the lower chords and floor system, but with-

out proper inspection or scraping. "In 1894 scales one-eighth of an inch thick were removed from the end stiffeners of the floor beams on the north side. Pieces of this scale were trimmed to exact dimensions and the cubic contents calculated." This scale was found to weigh more than one-half as much as new steel. In 1895 the bridge was again painted with two coats of iron-oxid paint, this time after thorough scraping, and it is now reported to be in good condition. Thus much for the influences to which the twenty-four plates were exposed when hung on the chord eye-bars above named. The results are presented in a tabulated statement, which names the kinds of paints used, and states how each pigment was applied and the time during which each plate was exposed. Other data, such as the date of the painting, the number of coats applied, and the date of exposure, are given. Finally the condition of each of the plates is described. Engineers will be much interested in these data, as presented by Mr. Mackenzie; suffice it to say here that, after exposures ranging from eight to twenty months for different plates, only five were found to be in good condition. Four more were in fairly good condition, and thirteen were in bad condition, "rusted all over," "very much rusted," "covered with rust; paint all gone," being samples of the terms used to described their different states. The article also presents a collection of data derived from various high authorities and bearing directly upon the effects upon iron and steel to be expected when these metals are exposed, without proper protection, to the action of salt air or the spray of sea water. Mr. Mackenzie regards the pigmentary matters mixed with the oil as of comparatively small importance. "The oil," he declares, "is king; any finely-ground pigment, inert toward the metal and oil, will last till the oil decays and wastes away, and against this waste and decay there is no remedy." The directions for applying paint to iron and the preparation of the metal for receiving the paint are comprehensive and specific. This is one of the best essays on the subject that has recently appeared.

A Remarkable Exhibition.

THE London Architectural Association celebrates its semi-centenary this year. As part of this celebration there has been placed on exhibition at the rooms of the institute a collection of architectural drawings and designs. Mr. R. Shekelton Balfour makes this exhibition the subject of a very readable article in the *Journal of the Royal Institute of British Architects* for July. The object of the exhibition appears to have been to present a chronologically-arranged collection of drawings and designs which might adequately convey an impression of the fifty years of evolution that have brought us to the "present-day draughtmanship, and the individual influences responsible for this evolution." This collection will also enable the observer "to follow in more subtle fashion all the strange phases of alternating admiration and unpopularity which have been formulated in the inconstancy of architectural fashions during the last fifty years." The chief characteristic of the exhibition is its wide recognition of "the intrinsic merit of different styles." Among the differences between the drawings of thirty years ago and those of the present time the increased employment of measured drawings is noted. "Formerly the measured drawing was not so largely in vogue as it is now, and the details of mouldings and enrichments were sketched to a small scale, with perhaps a few added dimensions at the side. Now our tendency is rather to reverse this process, and we draw our work out to scale on the spot, and persevere in making full-size drawings of all intricate and important portions." The result is visible in the decrease of perspective drawing in sketching-tours. The scale-drawing reveals defective proportion which a well-executed perspective pictorial representation might mask. "It was fifty-two years ago when one of the earliest drawings in the exhibition was made. This is an elaborately-inked-in water-color drawing of a church porch by Mr. J. K. Colling, which serves to illustrate the remarkable, though somewhat labored, effort which was so frequently relied on in those days

for effect." Three drawings in sepia and cobalt, executed in 1852, are also noted as being really pictures. The contrast between these and some adjacent ones, recently produced by the late W. Burges, A. R. A., is great. These "are distinguished by a boldness and originality which even our most advanced draughtsmen might hesitate to commit themselves to nowadays," and which "are pregnant with the character of their author." Of present-day architectural note-books, Mr. Balfour says that "they are a medley of jottings of all sorts and all dates of work;" much greater thoroughness is the characteristic of the sketches of the present date. "Thirty or forty years ago it was the *effect* produced by detail which was aimed at in the sketch-book. Now we go more to the root of the matter . . . and try to discover how the effect was produced." In perspective sketching—no longer the approved method—a good draughtsman may, and often does, unintentionally add a charm to his work which may conceal faulty proportions; and Mr. Balfour maintains that no mere sketch is a sufficient guide for the reproduction, in modern designs, of desirable effects transferred from old work. "The students' drawings of the last few years also tend to embody a paradoxical combination of slightness and elaboration; an amplitude of full-size details, coupled with an explanatory key-drawing of the whole for their elucidation. But in this we have the gist of the whole subject, a method surely preferable to the older one of filling in and completing the drawing with more or less accuracy, according to whatever the scale may be in which we are working." The closing decade of the period covered by the collection is most fully represented, showing great diversity of style and subject. The cosmopolitan taste of the present time is conspicuous in these exhibits.

The Improved Condition of Labor in England.

THE progress made in England during the reign of its present honored queen has been made the subject of a great deal of self-congratulation in the "British press." No one can find fault with this, for really this feeling has a solid foundation. The *Journal of Gas Lighting* (June 29) has an article entitled "Labor in the Victorian Age," in which it sets forth the enormous improvement in the status of labor in the last sixty years. The London *Times* is quoted as asserting that "no class in the community has more reason to be satisfied with the results of the last sixty years than the workingmen. It was the utmost demand of their best friends at the beginning of the present reign that they should be free to work out, by combination or otherwise, in their own way, their own salvation; that their societies should be legalized; and that the criminal law should not be used to increase the power of capital,—in a word, that they should suffer from no disabilities. They find themselves in 1897 in the position of a favored class, fenced about with special legislation, and possessed of some rights denied to others, and this period has also been for them one of unexampled prosperity. Their wages have risen, while the prices of food and most articles of consumption have fallen. The State educates their children *gratis*. The State makes the acquisition of allotment easy for them. The municipalities give them recreation grounds and free libraries; if they save, the State finds them an investment without risk, and pays them interest at a rate which they would not always obtain elsewhere. One of the latest acts of the house of commons was to approve a measure which, surpassing the dreams of labor leaders of sixty years ago, binds the employer to compensate an injured workman, even if the former is blameless. . . These ameliorations were not in the main extorted by labor leaders from a reluctant oligarchy, nor were they the work of 'popular,' to say nothing of paid, politicians. The factory acts, which have placed a large collection of the British operative population in a position envied by the same class in other countries, were freely granted from above, with no idea of propitiating a class of voters." There is a good deal more of the same sort, but at the end it is admitted that there

is another side to the picture. The decay of the old apprenticeship system, and the cessation of the friendly and direct personal intercourse once common between the employer and employed, are lamented. There is also in the cities a growth of the shiftless, thriftless class not amenable to any rapid improvement. However, these defects are thought to be more than compensated for by the grand advance of the laboring class as a whole.

The New Canadian Mail Service.

THE new line of transatlantic fast mail service, now arranged for, and which the Canadian government has long been anxious to obtain is submitted to some rather caustic criticism in *The Engineer* (London, July 2). Now that these arrangements are concluded, our contemporary doubts that the Canadian government is any nearer to the attainment of its desire, declared to have been the getting of a transatlantic mail service without paying for it; and, although the sum of £154,000 a year, to which it has obligated itself in the establishment of this service, is not exactly a trifle, the English critic says, not very urbanely, that, "if current rumors are to be trusted, the same cheese-paring niggardliness which has hitherto stood in the way of a Canadian mail service being organized is now likely to dwarf its efficiency and popularity when called into existence." The contract for this service has been awarded to an obscure firm in Newcastle-on-Tyne, hitherto owners of a line of cargo steamers. Of this firm *The Engineer* says: "As regards the gentlemen who have secured the contract for performing such a difficult service as that of running a line of fast mail steamers between these islands and Canadian ports during not only the summer, but in the winter season also, all we know is that they reside at Newcastle-on-Tyne, where they own or manage a fleet of some half-dozen or so of cargo steamers, which are called 'turret ships,' presumably because there is nothing at all like a turret about them. This is the sum of our knowledge of Messrs. Peterson & Tate, who, no doubt, are perfectly sincere in their belief that they know how to run a line of fast mail steamers; know what kind of ships are required for the service; know how much it will cost to build and run them, and what subsidy will recompense themselves and their shareholders for the capital put in the concern. But it is not sufficient for these gentlemen to have confidence in themselves; for the public who would like to avail themselves of the new service will demand some guarantees that, when they leave Great Britain in the company's steamers, they will be conveyed safely and comfortably to the other side." It is added that, if in respect of safety and comfort, speed and regularity, the new steamers do not equal the great steamers now plying between New York and Liverpool, the failure of the service is assured in advance. It is inferred that ships of the so-called turret type will be employed in this service. These ships are built by the Messrs. Doxford, of Sunderland. Our contemporary uses also the term "bottle-neck" as a special name for these ships; and, although it seems difficult to obtain reliable particulars of the ships to be built upon this type, the opinion is hazarded that such vessels—admittedly good as ocean tramps—are, on general principles, ill-adapted for a North Atlantic passenger trade, and that it will be impossible to make comfortable passenger ships of this type. The high freeboards and other features which have given to the great transatlantic ships of the present day such possibilities for comfortable accommodation of passengers would be wanting in what the critic calls the "'bottle-neck' monstrosity." A cheap construction at the expense of comfort and luxury in a line of modern transatlantic steamers would certainly be the direct road to financial failure.

Continuous Rails.

WITH reference to stresses upon continuous beams, to which class the railway rail is referred, *The Engineer* (London, July 9) points out that the condition of uniformity of section is absolutely and completely insured, but that "the rail does

not altogether satisfy another assumption put forward in treatises and text-books as indispensable to the security of the continuous principle, and that is that the points of support should be unmovable. Under the circumstances, it is fortunate that the rail does not vigorously comply with this theoretical proviso, for, if its points of support—that is, the sleepers—were so solidly grounded, it would not be long before hammering and hard running would place the whole permanent way *hors de combat*." A comparison of the rail considered as a girder with the system of bridge-construction invented by Gerber and patented in Germany shows some analogies. "In this system (Gerber's), instead of the girder being unalterably continuous from end to end, it is made continuous over the supports upon one side of it, only for a certain distance, which varies with the lengths of the span, and then hinged or pivoted at this point. Carried to its logical conclusion, this hinging or pivoting of the part over-hanging the points of support gives us the cantilever."

From this point of view *The Engineer* proceeds to build up an argument in favor of reducing the number of joints in a railroad track by using longer rails, or by another process which has lately come into vogue in America,—to wit, cast-welding the ends of rails together. Unquestionably the rail joints are the weakest points in the track. Rails exceeding a certain length cannot be conveniently rolled, transported, and handled. Our contemporary gives sixty feet as the longest rail ever yet laid on railways, but thinks that rails one hundred feet long have been rolled. The adoption of the continuous rail-tracks has been retarded by the fear of the effects of contraction and expansion under variations in temperature. It has, however, been proved that, for lengths of more than one thousand feet, temperature stresses need not be greatly dreaded. The ends of the individual rails in such a length may be joined either by electric welding, or by cast-welding, as it is called, which, while we believe it does not make so good a joint, is at present cheaper in first cost than electric welding. Our contemporary, however, thinks the joints made by cast-welding are equal to those made by electric welding, and perhaps our estimate of its efficiency is too low. It is certain that it has been satisfactory as a substitute for the ordinary rail-joint. That the temperature stresses really exist cannot, however, be doubted. They may be neglected, if experience proves that their effects are less injurious to a railway track than those of numerous joints.

Septic Tank Treatment, and Coal as a Sewage-Filtering Material.

It has recently been demonstrated that coal is a very efficient material for filtering sewage. A paper was recently read upon sewage-filtration by Mr. Donald Cameron, engineer of the city of Exeter, in which he presented to the Devon and Exeter Architectural Societies a description of the details of a septic tank installation at Exeter. Mr. Cameron seems to consider himself (probably with justice) as the inventor of the septic tank system, which has for its object to favor the multiplication of micro-organisms and to bring the whole of the sewage in the tank under their influence. These tanks are made of ample size, covered to exclude light and, as far as possible, air. The incoming sewage is delivered below the water-level; the outgoing sewage is also taken below the water-level, the purposes being to trap out air and to avoid disturbing the contents of the tank. The decomposition of the matters which would otherwise undergo putrefaction is effected by the presence of these micro-organisms, their products being water, ammonia, and carbonic acid, with some other gases. No sludge is found. The bottom of the tank, after six months' use, when exposed, shows only a thin layer of black earthy matter, together with mud and grit, which settles out of the water. A tenacious scum forms at the top, which consists of the lighter solids in process of decomposition. The effluent is not offensive, and it is claimed that it will not ferment, when the system is properly carried out, as the decomposi-

tion in the tank is complete. Thus purified, it may flow out upon land for fertilization, containing in solution all of the constituents valuable as food for plants. This system has attracted a good deal of attention, particularly in publications devoted to municipal affairs, as well as in architectural publications. *The Builder* (July 3) prints a paper by Dr. G. Reid, medical officer of health for Staffordshire, in which he not only approves of this tank system, but strongly recommends a system of filtering, which he calls the "New Garfield Filter," in which coal is used as the filtering material. He states that Mr. Garfield, manager of the Wolverhampton Sewage Works, accidentally discovered that coal slack was very effective in purifying dirty water. This led him to construct a small filter, with which he experimented upon the Wolverhampton effluent. The result was so favorable that, in company with Mr. Jones, a chemist, he instituted a set of experiments upon a larger scale, with still more encouraging results. He describes the filter, the bed of which is a bed of coal, the first six inches being made of coal nuts, in sizes of about one-half inch cube, blended with a layer of one-quarter-inch cube coal, above which is a nine-inch layer of one-eighth-inch cube coal, upon which is placed another layer of one-sixteenth-cube particles one foot nine inches in thickness. Upon the top of this is placed another layer of coal dust two feet thick, mixed with such coal as will pass through a three-sixteenth mesh. The tank effluent is discharged continuously upon this filter, for a period of twelve hours. Twelve hours are allowed for aeration.

It is claimed that a square yard of this filter will produce a highly-purified effluent, if charged at the rate of two hundred gallons for twenty-four hours. Above this rate the result is not so good. It is also claimed that the filter possesses exceptionally purifying powers, apart from nitrification—the nitrifying properties increasing with time. This new departure will be watched with a great deal of interest. We think it too early to forecast its future.

Educational Requirements for Electrical Engineers.

THE survival of the fittest, a law which holds good in the world of nature, also proves its validity in the struggle for place and profit in the active industries of the world. Considering how recently the profession of electrical engineering has come into existence, the extent to which it has become overcrowded is almost phenomenal. This is all the more remarkable when we consider the amount of technical and practical knowledge, required for the thorough equipment of electrical engineers. The rapidity with which the ranks have been filled in this field may be partly accounted for by the early overflow into it, from other departments of engineering, of men who had been unsuccessful, or only very moderately successful, in their practice. The technical schools now turn out each year numbers of new recruits more or less qualified to compete with those already engaged in the same kind of work. Of course, this accession to an already-filled branch of engineering practice absorbs some of the business which those now in it could do, and which they would like to get. This produces a set of conditions highly favorable to the operation of the law of the survival of the fittest, and the elimination of those whose equipment, ability, or character in other respects is defective. These either fall out of the ranks altogether, occupy inferior and unremunerative positions, or become, as *The Electrical Review* puts it, in an article on "The Training of an Electrical Engineer" (July 9) "men in a groove, along which they travel to the end, with their pluck taken out of them by repeated and vain efforts to pick up, now, what they failed to learn when young—or, disgusted with the retrospect, they turn to another career." This failure to gain the proper equipment before commencing practice is not always the fault of the individual who suffers from it. It is sometimes due to a defective course, which produces in the mind of a pupil only imperfectly instructed in theory the idea that he has been practically trained, and leads him to undertake that which he is incapable of executing.

It may be the failure of his instructors to perform their obvious duty toward him when, at the end of his first term or first year, he has shown his natural unfitness for the profession of engineering. Our English contemporary strikes at the very root of an evil which has gradually crept into modern systems of technical education when it says: "The fundamental idea that a man who has spent all his life in teaching, thinking, and reasoning is the proper person to entirely educate youths for any special practical profession is mischievous." Of course this idea is mischievous; the modern technical schools have recognized this in their provision for a more or less practical training in work-shop and field, under the direction of practical instructors. The principal weakness in this system is that, while such training in the schools is good, it cannot be carried far enough during a course of theoretical study, and that, though its insufficiency is precisely what should be impressed upon the minds of students, it has been the effort, in the catalogues of some of these institutions, to create an impression upon the public mind that it is thorough. Thus we read in such catalogues about the excellent forgings turned out by students in the forge shop, or the nice tools made by students in the machine shop, etc. The fact remains that even the brightest, quickest, and most assiduous of these young graduates, confronted with the really practical work of a regular machine-shop, or of the office of a civil engineer or architect in good practice, will, if sensible, soon discover that the practical training he received in the school was thorough only as far as it went, and that it did not and could not go very far. The conceited ass who comes out of his school with a graduate's diploma and the idea that he can now do anything, and can even successfully compete with those who have time and again met the practical difficulties of engineering and conquered them, will come to grief. There is another phase of this question. The over-filled ranks of the engineering professions show that, for merely *average* men, there are left only average positions or, as we perhaps could say with truth, less than average positions. First-rate men, failing to get first-rate positions, are fain to fall back upon merely average positions biding the time —which, indeed, may never come—when a vacancy of a first-class position may open to them. Even when such a vacancy occurs, the competition for it on the part of other first-rate men, occupying average positions, will be fierce, and only one will be chosen to fill it; thus the average position must be the one occupied by the majority of professional men, no matter how good their educational equipment. The possession of such an equipment, however, gives an aspirant a chance, when a door does open, that otherwise he would not get.

The New Denayrouze Burner.

It may be well to receive the current accounts of this new gas-burner with some reserve, until they are confirmed or disproved by subsequent developments. It is safe so say, however, that, if the statements published in foreign journals—for example, the *Journal of Gas Lighting* (July 6)—approximate closely the actual facts, the gas industry has been put into possession of a rival of the electric light which the latter will find to be a powerful competitor. It is said that by substituting for the hitherto employed electric motor, or the jack-wheel mechanism for creating draft, a device called an "expansion chamber," as good results in illumination are secured as by the mechanical method. By this device, it is said, air and gas in suitable proportions are brought together and mixed, acquiring just as much motive force as when propelled by a fan. The expansion chamber is placed between the mantle and the Bunsen burner. Exactly how it operates to produce the result claimed is not very clearly explained.

THE FRENCH AND GERMAN PRESS

The Electric Furnace.

AMONG the papers presented at the convention of the Electrochemical Society at Munich, and published in the *Zeitschr. für Elektrochemie* for July 5, is an interesting discussion of the widening uses of the electric furnace, particularly in applied technology. A paper was read upon the subject by Herr Pflegler, of Frankfurt, who called attention to the absurd claims made in some quarters as to the capacity of such furnaces, in view of the known theoretical possibilities. In fact, an electric furnace is a tremendous power-eater. A furnace which consumes a current representing 250 to 300 electrical h. p. is an insignificant-looking apparatus compared with that required for the generation of the energy which it so readily absorbs. In the case of the manufacture of calcium carbid, Pictet has shown that theoretically 1 h. p. can produce in 24 hours a little less than 4 kilograms of calcium carbid. Nevertheless a number of builders of electric furnaces and promoters of enterprises have claimed results superior to this maximum theoretical output. Claims are made for some furnaces that they will readily produce 9 to 12 kilograms per horse power in 24 hours, regardless of the absurdity of such statements. The actual conditions as to temperature in such furnaces are practically the same in all constructions, depending entirely upon the current, and the only improvements which may be looked for in construction must be in the direction of preliminary heating of the materials, reduction of losses by radiation, etc., enabling the theoretical maximum to be approached, but certainly never exceeded. Herr Pfleger cites a case in which an electric furnace of English construction was erected in Spain under a guarantee to produce 12 kilograms per horse power in 24 hours, but so ignorantly was it designed that, when the current was started, the whole furnace melted down to a heap of slag! Besides the production of calcium carbid, the electric furnace is finding application for the separation of metals by distillation. Some curious results have been obtained in these directions, since the distillates do not appear to consist of the pure metals, but rather to be real gases, containing hydrogen, and giving in the spectroscope numerous lines which do not belong to the metals vaporized. Another application of the electric furnace is that of the production of phosphorus from alkaline phosphates, for which several patents have been taken out, and which involves temperatures below those required for the production of carbid. Altogether, the future of the electric furnace in the domain of chemical technology seems to be materially extending, and, with enlarged experience, many new applications will doubtless be found.

Street-Washing in Germany.

UNDOUBTEDLY one of the best methods of keeping streets clean is that of frequent flushing with water, especially when the sewer outlets are so planned as to permit all the solid refuse to be washed out through them along with the water. In many cases, however, the supply of city water does not permit the liberal flow necessary for a thorough flushing, so that this luxury can be permitted only when an excess of water is on hand. The city of Oldenburg, near Lubeck, has provided an independent water-supply for the especial purpose of keeping the streets washed, this being one of the numerous sanitary improvements which have resulted from the cholera epidemic of 1892 in the North seaports. The following details of the installation are from the issue of the *Gesundheits Ingenieur* for July 15. In order to avoid the cost of new buildings, the pumping plant is placed in one of the electric stations where space was available, the water being taken direct from the river Hunte, the pumps being driven by belt from turbines. A system of high-service mains, altogether distinct from the regular water-supply, is connected with

this pumping plant, and a pressure of 65 feet head is maintained by an automatic regulator permitting the excess water to be returned to the river whenever the demand is reduced. This high-service pumping system supplies thirty-seven flushing hydrants placed at such points of elevation as to permit the streets to be cleared by the slope. The hydrants are so arranged that their ordinary discharge is through openings in the curb at the gutter line, but they can also be immediately converted into fire plugs for hose attachment, either for street-sprinkling or for fire-engine supply. Since the river water at Oldenburg is unfit for household use, the plant above described is available only for the special purposes for which it was planned, but the expense of thus using a local supply of brackish water for purposes of street-washing and fire-service is so moderate that the method is worthy of consideration in other localities. The entire cost of the Oldenburg plant was less than $7,000,—that is, less than $200 per hydrant,—while the economy in street-cleaning alone would soon repay this, after which the cost of operation would be much less than by any other method, not to mention the superior sanitary advantages.

The Jungfrau Railway.

WE have noted in previous issues the progress of the rack railway now being constructed to carry tourists to the summit of the Jungfrau, but one of the peculiarities of this road is worthy of special notice—*i.e.*, the motive power. This is described and discussed in an article by Herr E. Strub, in the issue of the *Schweizerische Bauzeitung* for July 17, with a profile of the railway and sectional views of the engine. The motive power is to be electricity, an overhead-trolley system having been adopted. The current is to be generated from the water power produced by the ice melting and flowing down into the valleys in ample volume and head for all the requirements of the plant. This source of power most accommodatingly adapts itself to this service. In summer, when Switzerland is full of tourists, the rapid melting of the ice and snow keeps the streams unfailingly full; in spring and fall a fair supply is available; while in winter, when power might posssibly be lacking, there is no demand, all of which is most convenient. The maximum power required for a load of 80 passengers on the maximum grade of 25 per cent. is 211 h. p., and, an allowance of 50 per cent. efficiency being ample, the plant has been arranged for a turbine power of 500 h. p. for each train. The generating plant is to be installed at once, so that it may be used for the work upon the road, operating the construction cars, rock-drills, lighting, etc., and be in working readiness as soon as the roadway is completed.

The drawings given of the electric locomotive show that every precaution has been taken to assure power, safety, and control. The mechanism is doubled throughout, there being two motors, each with its own gear train to its own pinion engaging with the rack between the rails, with ample power for independent propulsion, while a triple system of brakes provides for the safety of the passengers in an emergency.

As several engines and cars may be on the road at the same time, the power plant is made of sufficient capacity to supply 2,000 h. p., but at first only two 500-h. p. turbines will be installed, the others being left until the demands of travel shall require them. The water will be brought in a wrought-iron pipe nearly a mile long and 5 ft. 11 inches in diameter, the effective fall being 116 feet, and the volume averaging 212 cubic feet per second. The power plant will be situated at Lauterbrunnen, where it will doubtless be an attraction to engineering visitors as well as to tourists making the ascent.

Improvements in the Cinematograph.

THE modern devices for the projection of moving images upon a screen before an audience, known under a multiplicity of names, such as the cinematograph, biograph, kinetoscope, etc., maintain their popularity, in spite of numerous defects and objections. Of these the most serious are those of danger of fire, due to the

proximity of a film of celluloid to the intense heat of the electric arc, or the oxy-hydrogen lamp, and the annoyance and fatigue caused by the unsteadiness of the images and the flickering of the illumination. The disastrous fire at the *Bazar de la Charité* in Paris has led to the invention of various safety-devices against fire, but a simple and effective precaution against such accidents is readily found in a water screen between the light and the film. The Amschutz Cinematograph, described in *La Revue Technique* for June 25, is intended to overcome the flickering of the present forms of apparatus, and its success abroad seems to warrant the claims made for it. As is well known, the operation of the cinematograph depends upon the rapid projection of successive images, and in all the present forms the light is obscured while the film is in motion. Between the light and the film is a device which is the counterpart of the photographic shutter with which the original images were made, and thus successive flashes of light are made corresponding with the successive series of pictures. It is this intermittent flashing of the light which produces the well-known flickering. The Amschutz device seeks to obviate this by using two lights and two sets of pictures. Everyone is familiar with the dissolving-view apparatus, by which one picture is made to melt away into the next. In the Amschutz cinematograph there are two lights, two films, and two projecting lanterns. The lanterns are inclined so that their pictures are projected on the same spot. The pictures are arranged alternately on the two films, all the odd numbers being on the first and the even ones on the second. The shutters are so arranged that one light is exposed as the other is obscured, and the illumination is practically continuous. The effect is said to be a vast improvement on the intermittent system, the annoying flicker being entirely absent, and a steadiness and smoothness attained which adds greatly to the comfort and satisfaction of the spectators. Doubtless further improvements will continue to be made until a high degree of perfection has been, reached.

Frictional Resistance of Riveting.

ALTHOUGH the strength of a riveted joint lies mainly in the shearing strength of the rivets and plates, yet it is usually recognized that the frictional resistance of the parts adds more or less to the strength, according to the manner in which the joint is made. The exact amount and nature of this resistance are generally more a matter of conjecture than of precise knowledge, and any contribution to our stock of information in this direction must be welcomed. A number of experiments have recently been made in Holland by M. J. Schroeder van der Kolk, and published in the Transactions of the Royal Institute, and these valuable results are now given to the public in the issue of the *Zeitscher. d. Ver. deutscher Ingenieure* for June 26, with illustrations and many diagrams. The experiments included a great variety of conditions, covering both hand and machine riveting, with holes of various sizes and with various arrangements of rivets, the object being especially to discover the true strength of riveted work in bridge-construction and similar work. Space will not permit a full account of the work and the entire record of results, but the general summing-up contains many points of interest. The frictional resistance was shown to be a much greater factor in the strength of a girder than is usually admitted, but this source of strength is greatly diminished if for any reason the plates begin to slip, since the working of the plates with every vibration soon loosens the contact sufficiently to cause the friction to become insignificant. One source of this reduction of friction is the unequal elasticity of the various members. Thus in a butt joint the cover strips should have the same elasticity as the plates themselves, or else, under deflections quite within the elastic limit, the parts will begin to work upon each other to an extent which will soon diminish the friction; hence this fact should be taken into account in proportioning the members of a joint. A similar action also occurs in built-up girders and like constructions, and in all such cases the question of relative elasticity should be con-

sidered. The diagrams show that the frictional resistance is a very important factor in the strength of riveted work, the yield of the joint increasing very rapidly after slippage begins to take place.

The elasticity of the rivets is important in this action, as well as that of the plates, and when, as in hand-riveting, the rivets do not entirely fill the holes, better results are obtained by having the holes slightly larger than the rivet diameter; with machine-riveting, however, it was found desirable to have the holes well finished close to size. The entire subject is very thoroughly treated and fully illustrated in the articles referred to, and it is to be hoped that similar tests will be made in other countries to confirm or modify the results, as the case may be, by adding to the meager stock of data at present available.

Coal Calorimeters.

THE determination of the calorific value of a given fuel is becoming of more and more importance, in view of the tendency at the present time to refer all tests of heat motors to the actual calorific capacity of the fuel used. Various methods are in use for this purpose, the deduction from the chemical analysis being the principal one; but, whenever possible, it is desirable to check this by an actual test of the fuel by measuring the number of heat units evolved during combustion in a special apparatus. A full discussion of the subject by Herr L. C. Wolff, based upon experimental investigations made in the laboratory of the Magdeburg Steam Users' Society and published in the *Zeitschr. d. Ver. deutscher Ingenieure*, contains some points worthy of special attention. Referring first to the chemical method, Herr Wolff notes that the formula of Dulong:

$$8100\ C + 28800 \left\{ H - \frac{O}{8} \right\} + 2230\ S,$$

should be somewhat modified, if all the conditions are to be provided for. A portion of the sulphur is burned to $S\,O_2$, and the coefficient of this should be 3,300, instead of 2,230. The hygroscopic water contained in the coal is vaporized, and passes up the chimney, and for this an allowance of 600 units may be made as an average value. The principal constants are subject to slight modifications because of later determinations, and these, when incorporated, give what is known as the "Verbands-Formell," from the fact that it has been adopted by the German Society of Engineers and by the International Society for Boiler Inspection. The formula reads:

$$\text{Calories per Kilo} = 8000\ C + 29000 \left\{ H - \frac{O}{8} \right\} + 2500\ S - 600\ W,$$

all values being in the metric system, and W indicating the hygroscopic moisture in the coal. The use of any formula, however, involves a chemical analysis, while with a suitable calorimeter the calorific value may be determined directly with little if any more labor or expense than is involved in analyzing the fuel. The principal calorimeters used are the Berthelot and its modifications, or the Mahler bomb, which in Germany has been especially used with success by Prof. Stohmann. The principal objection to these instruments has been their high first cost, but Herr Wolff describes a simplified form of bomb designed by Dr. Kröker, which is reasonable in price, costing only $107 and possessing some advantages, particularly an attachment for measuring the quantity of steam evolved, by absorbing it in calcium chlorid. Herr Wolff's paper gives some interesting examples of the application both of the Kröker and the Mahler-Stohmann calorimeters, with the computations fully worked out. Altogether it must be considered a valuable contribution to practical thermodynamics.

A French Aeroplane.

THE success which has attended the experiments of Professor Langley towards the solution of the problem of mechanical flight gives added interest to an account of the experiences of MM. Tatin and Richet, contributed by M. Marey to *Comptes Rendus* for July 5, in the form of a note to the French Academy.

These experimenters formally announce that a steam aeroplane weighing 73 pounds

sustained itself in the free air, and traversed a distance of 460 feet in a straight line at a velocity of 59 feet per second, propelled by its self-contained motive power. The machine consisted of a body containing the motor, sustained by two fixed wings of about 86 square feet of surface, and with a spread of 21.7 feet, together with a fixed tail to steady the flight. The car was made of light pine wood, and the whole apparatus thoroughly braced together with a system of steel wires. The area and inclination of the supporting surfaces were computed according to the formulas of Duchemin, modified by the necessity of considering the obstruction due to the wire trussing and framework. The actual power was estimated as double that theoretically required by the angles, weights, and velocities assumed; and in practice it was found that the above velocity of 59 feet per second was necessary to sustain the apparatus. The motor consisted of a small steam engine with boiler and furnace complete, operating two screw propellers, one in front and the other behind, revolving in opposite directions. The total weight of 73 pounds included sufficient fuel and feed-water for a flight of more than three miles. A similar apparatus was tried as long ago as 1890, and flew successfully for a distance of 250 feet, when one of the wires broke and became entangled in a propeller, throwing the machine to the ground and wrecking it.

The present apparatus was constructed in 1896, and, after some mishaps, was put in complete order, and, as above related, made a successful flight in June of this year. The constructors are assured that these experiences have demonstrated to them the correctness of their assumptions, and will persist in the effort to attain still greater success on the same lines.

Submarine Telegraphy.

A NOTE recently presented to the French Academy by M. Leaute, and published in *Comptes Rendus* for June 14, describes a new receiving apparatus for submarine cables devised by M. Ader, which possesses some novel and valuable features. At the present time the transmitting-capacity of a cable is limited by the receiving apparatus, it being difficult to surpass a speed of more than six hundred signals per minute. Both the mirror receiver and the siphon recorder of Lord Kelvin are limited by the fact that a certain time is required for each oscillation, and that, when too rapid transmitting is attempted, the signals become undecipherable, owing to interference of one vibration with the next, due to inertia of the parts with the siphon recorder, and to the fatigue of the eye with the mirror apparatus. The improved recorder of M. Ader is based upon the action of a magnetic field upon an element of current. The magnetic field is furnished by a powerful permanent magnet, between the poles of which passes a fine wire traversed by the current transmitted through the cable, this wire being strained by a small tension spring at one extremity. According to well-known laws, the wire tends to displace itself, either forward or backward, as the direction of the current may determine. Since the wire is supported at both ends, it oscillates; and its oscillations bear a definite relation to the electrical waves by which it is traversed. The wire used is only 0.02 mm. in diameter, and responds very promptly to the variations of the forces by which it is solicited. By using a very minute distance between the contact points of the transmitter—not more than 0.0005 mm.—the magnetic circuit is almost closed, and the apparatus operates under the best conditions. The vibrations are recorded photographically, giving a permanent record, which may be translated subsequently, while the speed of transmission, and consequently the capacity of the cable, are greatly increased. In the first instrument made, a speed of six hundred recorded signals was attained on the transatlantic cable between Brest and St. Pierre, though the previous recorder had not surpassed four hundred signals; while on the cable between Marseilles and Algiers the new apparatus records sixteen hundred signals per minute, as against a maximum of six hundred for any other apparatus which has shown practical results heretofore.

A Railway Speed Indicator.

In the course of some experience recently made on the Berlin locality and published in *Glaser's Annalen* for July 15, it became necessary to procure a record of the speed of trains on various portions of the road. For this purpose a very simple and successful recording speed-indicator was devised by Inspector Leissner, which is worthy of notice here. The apparatus consisted of an ordinary Morse recording instrument, the paper strip being moved by clockwork and the contact being made and broken by a sort of commutator on the car axle. The commutator was arranged so that two contact springs rested upon a sleeve on the shaft in such a manner that current flowed for one half a revolution and was interrupted for the other half, thus making a dash and a space on the ribbon correspond to one revolution of the axle. Since the paper is given a uniform motion, it is evident that, when the train is moving slowly, the dash and space will be longer than when a higher speed is attained, and a glance at the ribbon will show whether the train is moving rapidly or slowly. By marking the length of ribbon corresponding to the one minute of time, and counting the number of dashes contained therein, the number of revolutions is given at once, and from the diameter of the wheels the actual speed can be computed very precisely. In the experiments referred to, the paper ribbon was ruled so that one second of time was represented by one millimeter of space, and, by subsequent plotting of curves, a graphical record of the speeds at various portions of the road and under various conditions was obtained. Besides the record of speed, these diagrams furnish other valuable information, such as the rate of starting, the time required to attain maximum speed, the time in which stops are made, speed around curves and up grades, and other similar points. Such a speed-recording apparatus should be very useful in connection with indication of locomotives, as the actual speed conditions for the diagrams could readily be obtained after the tests, simply by noting the exact instant of time and then comparing the speed diagram when the cards were being worked up. The simplicity of the device and the readiness with which it can be constructed from existing telegraph apparatus should render its use a matter of small cost.

The Action of the X Rays on the Retina.

It has hitherto been assumed that the X rays are without action on the retina, although a few observers have asserted that some subjects have experienced a slight luminous impression when placed in the axis of the radiations. A note presented to the French Academy by M. d'Arsonval for M. G. Bardet, and published in *Comptes Rendus* for June 14, records some interesting observations on this point. The assertion has been made that the real reason why no action is felt by the retina is that the eyeball is opaque to the rays, and that this effect is particularly due to the action of the crystalline lens; in proof of this it has been stated that subjects from whom the lens has been removed by the operation for cataract are found to have acquired the capacity of perceiving an action when the rays are permitted to fall upon the retina, although negative results are reported by Darieux. M. Bardet, however, asserts that all the subjects observed by him have been able to experience an action upon the retina, and that the substance of the eye, while probably offering some resistance to the passage of the rays, is not entirely opaque to them. In order that the phenomena should be observed, however, it is necessary that numerous precautions be taken, as the action is very feeble and can be perceived only in absolute darkness. The observer is placed in a closed cabinet, all light being excluded by heavy curtains, and the Crookes tube being placed outside, as the wood and the curtains offer no obstruction to the passage of the rays. No paint whatever should be on the wood, as most colors become more or less fluorescent under the action of the rays, and might cause deceptive results. Under these conditions, when the eye is placed a few inches from the tube without, the retina experiences a luminous sensa-

tion similar to that which occurs when a lighted candle is quickly passed before the closed eyes. This sensation is not interrupted by the interposition of a sheet of aluminum, but is at once stopped by the use of a sheet of iron, copper, or lead. When a piece of glass is interposed, the luminous effect is greatly reduced, but in this case the glass must be without the cabinet, since it becomes fluorescent. The luminous sensations are feeble, but distinct, and are synchronous with the vibrations of the tube, and, when the latter is so turned that the eye is no longer in the axis of the rays, the effect disappears, showing that the impression is not due to the action of the electrical field. All materials which are transparent to the X rays permit also this retinal action, while all those which obstruct their passage cause the luminous impression to cease. In view of the uniformity of these results, M. Bardet thinks that there can be no doubt that the X rays produce an impression upon the retina, the only point as yet undetermined being the possibility that the effects observed may be due to a fluorescence of certain portions of the eye itself.

A New Spanish Cruiser.

EVERYTHING which relates to the naval strength of Spain possesses especial interest at the present time; hence we give, from *La Revue Technique* of July 10, the following particulars of the new armored cruiser Cristobal Colon, which has recently been completed by the Ansaldo works at Genoa, and which successfully passed her speed trial on April 30 of this year. This vessel is claimed to be one of the most powerful fighting machines in Europe. The hull is 328 feet in length by 60 feet beam and 23 feet draft; the displacement 7,000 tons, and the total horse power 14,000. The entire hull is protected by a belt of 15-centimeter nickel-steel armor, above which is a citadel extending two-thirds of the length of the ship, bearing armor of the same thickness, together with two barbettes; these latter carrying each a gun of 254 centimeters' bore, while the battery in the citadel is composed of ten six-inch rapid-firing guns; there are also a number of smaller guns on the bridge and in the tops. The machinery is covered by a curved protective deck of 1 to 1.2 inches thick, extending over the whole length of the ship. The propelling machinery consists of two triple-expansion vertical engines of 6,750 h. p. each, and 500-h. p. auxiliary machinery. The most interesting portion of the motive power, however, is found in the boiler-room. Here are twenty-four water-tube boilers of the Niclausse class, arranged in four batteries, and adapted to work at 200 pounds' pressure, developing 14,000 h. p. The total weight of the boilers, including water, flues, and all auxiliary apparatus, is about 376 tons, giving a weight of about 59 pounds per h. p., or, for the empty boiler alone, about 44 pounds per h. p. This weight is much lower than that possible with the Scotch boiler, and is even lower than that usually attained for water-tube boilers in large vessels. The Cristobal Colon made her first trial on April 28, when, under natural draft, she made 19.35 knots for four hours, the machinery working in a most satisfactory manner. On April 30 a second run was made over a course of 22 miles, when a speed of 19.6 knots was attained, or 1-10 knots more than the requirement. This result was so satisfactory that the Spanish government officials decided that forced-draft trials were unnecessary, and on May 4 an eight-hour run was made to determine the efficiency of the machinery. With an average speed of 18.3 knots, a consumption of 1.62 pounds of coal per horse power per hour was obtained, and the inspectors state that this economy could be maintained continuously without special effort. These figures are of especial interest in comparison with those obtained by previous trials with the Garibaldi, a cruiser built by the same establishment and identical in every respect with the Cristobal Colon, except that the boilers in the Garibaldi are cylindrical. The latter vessel, on her speed trial under conditions similar to those above stated, could not make over 18.3 knots, showing a difference of 1.3 knots, due to the increased efficiency of the boilers. The new

cruiser is an important addition to the Spanish navy and a great credit to her Italian builders.

A Suggestion in Electric Railways.

WHILE doubtless the application of electric motive power will ultimately be extended to regular railway service, it is hardly to be expected that so great a change can be made in a short time. Intermediate steps, however, may be taken which will lead to the accomplishment of that end gradually, and one of those steps may be found in a suggestion of Herr Schiemann in the *Deutsche Zeitschr. fur Elektrotechnik* for June 15. This plan is to construct cheap lines of narrow-gage electric railway along the main highways of merchandise traffic, running upon them low flat top cars upon which ordinary wagons can readily be placed. A train would then consist of these low trucks carrying each a wagonful of goods without horses, and requiring no attention at the destination save that of dismounting and hauling away. Such a road, running through an agricultural country, would enable a farmer to drive his own wagon to the nearest station, and, without handling or unloading, to have the vehicle and its contents picked up and carried at high speed to the market, where local horses would haul it intact to the wharf or market-house. Herr Schiemann thinks that for much of the local and country traffic such a combination of wagon- and railway-hauling would enable merchandise to be transported at rates and under conditions impossible at present, and these light railways would prove valuable feeders for the great trunk lines for many sections of country at present without adequate connections. While the experienced railroad man will see many objections to this apparently primitive suggestion, yet there is no doubt that in many instances such a system would be found to have advantages, particularly in the short hauls that involve expenses for handling which are out of all proportion to the distance. The passenger trolley lines have, in many cities, transformed the commercial relations of various business localities, and made many changes in real estate values and it is possible that some such system of rural merchandise-transportation as that suggested by Herr Schiemann may be developed with equally important results.

Decimal Time Again.

SEVERAL months ago we referred in these columns to the agitation of the question of decimal subdivision of the hour and of the quadrant, and the matter has now been discussed by the *Société des Ingénieurs Civils des France*, a report of the discussion being published in *La Revue Technique* for July 10. In the discussion it appeared that the change was not supported by geographers or by engineers, and that its use would cause far-reaching confusion in many directions. Thus a kilogrammeter-second is the energy necessary to raise 1 kilogram through a height of 1 meter in 1.6666-decimal seconds. In like manner the whole C. G S. system of absolute units would be thrown into confusion, just as that system, after a number of years of effort on the part of scientists throughout the world, is coming into general use These and other objections were discussed at some length, as were also the arguments, *pro* and *con*, concerning the division of the quadrant into 100 degrees; but no definite conclusion was reached, the entire matter being referred to the government commission. There seems to be small doubt, however, that the general sentiment was against the changes, especially in view of the practically universal use of the existing system.

THE ENGINEERING INDEX.

A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN, BRITISH AND CONTINENTAL ENGINEERING JOURNALS.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

Age of Steel, The *w.* $3. St. Louis.
American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Annales des Ponts et Chaussées. *m.* 31 francs. Paris.
Architect, The. *w.* 26s. London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Architektonische Rundschau. *m.* 18 marks. Stuttgart.
Arena, The *m.*. $5. Boston.
Atlantic Monthly. *m.* $4. New York.
Australian Mining Standard. *w.* 30s. Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18s. London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23s. 8d. London.
Builder, The. *w.* 26s. London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27s. 6d. London.
Compressed Air. *m.* $1. New York.
Comptes Rendus de l'Academie des Sciences. *w.* Paris.
Contemporary Review. *m.* $4.50. London.
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago.
Electrical Engineer. *w.* 19s. 6d. London.
Electrical Engineer. *w.* $3. New York.
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21s. 8d. London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6d. London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36s. London.

Engineers' Gazette. *m.* 8s. London.
Engineering. *w.* 36s. London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Journal. *s-m.* 50 cts. Stanford Univ.
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6d. Birmingham.
Gas World, The. *w.* 13s. London.
Gesundheits-Ingenieur. *s-m.* 16 marks. München.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Harper's Weekly. *w.* $4. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8d. London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4d. London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $6. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Electricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Le Moniteur Industriel. *w.* 40 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 8s. London.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7s. 6d. London.
Marine Engineering. *m.* $2. New York.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8s. 8d. London
McClure's Magazine. *m* $1. New York.
Metal Worker. *w.* $1. New York.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver.
Mining Journal, The. *w.* £1. 8s. London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart
Moniteur Industriel. *w.* 40 francs. Paris.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* 24 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6d. London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
State's Duty, The. *m.* $1. St. Louis.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
Technic, The. *yr.* 50 cts. Univ. of Mich.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5s. London.
State's Duty, The. *m.* $1. St. Louis.
Western Electrician *w.* $3. Chicago
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

ARCHITECTURAL Work.

The Work of George Edward Harding & Gooch. A critical review, with illustrations. 4800 w. Arch Rec—July-Sept. 1897. No. 14227 C.

BETON.

Béton Buildings at the Beocsin Cement Works. (Bétonbauten in den Beocsiner Cement Fabriken.) An account of various buildings of concrete, including a concrete tunnel for rope transmission; also rows of workmen's houses. 1 plate. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14152 D.

The Applications of Reinforced Béton. (Les Applications du Béton de Ciment Armé.) Describing the Hennebique construction of T beams of concrete, with iron rods imbedded in the lower portion. 3500 w. Revue Technique—June 25, 1897. No. 14139 D.

BOMBAY.

Dwelling Houses in Bombay. (Wohnhäuser in Bombay.) A. Meissner. An interesting account from personal observation, with especial reference to English work. 1 plate. 3000 w. Oesterr Monatschr f d Oeffent audienst—July, 1897. No. 14153 D.

BOWLING GREEN Building.

See same title under Electrical Engineering, Miscellany.

CHURCH.

Design for a Greek-Catholic Church at Zastavna. (Project für eine Griechisch-Katholische Kirche in Zastavna.) An interesting example of effective wooden church construction. 3 plates. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14151 D.

Wimborne Minster. S. Beale. Illustrated Description of a Norman church, its altars, tombs, relics, &c. 3000 w. Am Arch—July 10, 1897. No. 13986.

COLUMBIA University.

The University of Columbia. F. M. O'Reilly. Part first is introductory, reviewing the development and the current work. Later articles will describe the architectural features of the various buildings. 2000 w. Engng—July 2, 1897. Serial. 1st part. No. 13964 A.

FERRY House.

New Ferry House at San Francisco, Cal. Illustrated detailed description of new structure being built at the foot of Market St. to accommodate heavy suburban traffic and the main line traffic of the railways. 1800 w. Eng News—July 29, 1897. No. 14331.

FIRE Precautions.

Precautions against Fire in Metallurgical Works. Discusses faults in mill construction, and calls attention to points requiring care. 1000 w. Eng & Min Jour—July 17, 1897. No. 14038.

FIREPROOFING.

Reports of Insurance Companies' Experts on the Pittsburg, Pa., Fire. Parts of reports of interest as indicating the manner in which this fire and its action impressed the insurance experts, and as giving their ideas as to the defects shown to exist in fireproof construction, with editorial. Ill. 6500 w. Eng News—July 15, 1897. No. 14019.

FOUNDATIONS.

Pneumatic Caisson Foundations for the Mercantile Building, New York City. Illustrations and description of features of particular interest. There were nine timber and five steel caissons, and the success and rapidity with which the work was accomplished without disturbing the neighboring structure is worthy of note. 1100 w. Eng News—July 15, 1897. No. 14020.

HOSPITAL.

The Park Hospital, Hither Green, S. E. Illustrated description of a new fever hospital in England. 2500 w. Eng, Lond—July 16, 1897. No. 14260 A.

INDEPENDENCE Hall.

Restoring Independence Hall. Asa M. Steele. An account of the effort being made to restore the group of buildings to their original condition, at the time of the signing of the Declaration of Independence. Ill. 2000 w. Harper's Wk—July 24, 1897. No. 14092.

N. Y. LIFE Building.

See same title under Electrical Engineering, Power.

SCHOOL Building.

A School Building and Town Hall of Moderate Cost. Illustrated description of the Washington school building, situated in West Orange, N. J., planned to be used for a town hall and primary school house. 900 w. Eng Rec—July 17, 1897. No. 14054.

TILE Protection.

See same title under Railroad Affairs, Maintenance of Way.

VAULTS.

Groined Vaults. Discusses the knowledge of vaulting possessed by the builders of the thirteenth and fourteenth centuries, with some reference to earlier work. 2500 w. Arch, Lond—July 9, 1897. No. 14052 A.

HEATING AND VENTILATION.

BLOWER System.

A Blower System of Furnace Heating. Illustrated description of the system of heating and ventilation used in school No. 2, East Albany, N. Y. 1300 w. Met Work—July 31, 1897. No. 14344.

EXHAUST Steam.

Practical Determination of Mean Pressure. Heating with Exhaust Steam. Discusses when it is economical to use exhaust steam, and methods of determining the point at which economy begins. 900 w. Am Elect'n—July, 1897. No. 13896.

GREENHOUSES.

Heating Greenhouses. L. R. Taft, in the *Florists' Exchange*. Extracts from article. Discusses boilers, grate and heating surface, radiation, piping, heating by steam and by steam and hot water combined. 4000 w. Met Work—July 24, 1897. No. 14225.

Hot-water Heating for Greenhouses. J. D. Eisele. Condensed from a paper read before the Philadelphia Florists' Club. Discusses the selection of boilers, the elevated boiler system and the economy. 2000 w. San Plumb—July 15, 1897. No. 14028.

HEATING Apparatus.

See same title under Railroad Affairs, Maintenance of Equipment.

HOT BLAST System.

Automatic Regulation of the Hot-Blast System of Heating in the Racine High School. Illustrated detailed description. 1500 w. Heat & Ven—July 15, 1897. No. 14077.

HOT WATER Heating.

A Hot Water Heating Plant in St. Louis. Illustrated detailed description of hot water plant in residence of Byron Nugent. 2400 w. Eng Rec—July 10, 1897. No. 13956.

HUMIDITY.

The Humidity of the Air. (Die Feuchtigkeit der Luft.) Bruno Griep. Discussing the importance of introducing moisture into artificially warmed rooms, in order that the most healthful proportion may be maintained. 1000 w. Gesundheits Ingenieur—June 30, 1897. No. 14165 B.

LARGE Heaters.

Economical Heating. Claims that large heaters will alleviate many of the ills complained of, and prove economical in consumption. 1200 w. Dom Engng—July, 1897. No. 14233 C.

LILY Pond.

See same title under Landscape Gardening.

POST-OFFICE.

Heating and Ventilation of the Detroit Post-Office. Illustrated description of a plant planned with more than ordinary care. 1700 w. Eng Rec—July 31, 1897. Serial. 1st part. No. 14415.

SHIP Ventilation.

See same title under Marine Engineering.

STEAM Plant.

A High Pressure Steam Plant. F. L. Ray. Some observations on its design and operation. 2700 w. Bos Jour of Com—July 17, 1897. No. 14029.

VENTILATION.

The Choice of Ventilating Systems for Schools, Theatres, Churches, &c. (Die Auswahl des Ventilations-Systems für Schulen, Theater, Kirchen, u. s. w.) A paper read before the sanitary association of Berlin by Prof. Rietschel. 3000 w. Gesundheits Ingenieur—July 15, 1897. No. 14170 B.

WARMING.

The Warming and Ventilating of the Reichstags Building in Berlin. (Die Heizungs-und Lüftungsanlage des Deutschen Reichstags hauses in Berlin.) Karl Schmidt. A very fully illustrated description of this large plant, recently installed in the buildings of the German Capital, at a cost of $200,000. Two articles. 1 plate. 7500 w. Gesundheits Ingenieur—June 15 & 30, 1897. No. 14163 E.

LANDSCAPE GARDENING.

LANDSCAPE Gardener.

The Landscape Gardener and his Work. O. C. Simonds. Extract from an article published in *Park and Cemetery*. On the knowledge essential in successful landscape gardening. 1700 w. Gar & For—July 21, 1897. No. 14091.

LILY Pond.

Heating the Lily Pond in Prospect Park. Describes the arrangements used in the Brooklyn park, making it possible to grow the tropical flowers. Ill. 800 w. Met Work—July 31, 1897. No. 14343.

PARK Maintenance.

One Way to Reduce the Cost of Park Maintenance. Urging the making of parks less pretentious and constructing them in the outset in the most thorough manner, and in such a way that they may be cared for more cheaply. Editorial. 1000 w. Gar & For—July 14, 1897. No. 13995.

TREES.

The Effects of Wind on Trees. J. B. S. Norton. From a paper read before the St. Louis Academy of Science. The results of observations made at the time of the great tornado, and followed by more recent study. 1300 w. Gar & For—July 28, 1897. No. 14311.

PLUMBING AND GAS-FITTING.

ASYLUM.

Some Plumbing in an Insane Asylum. Illustrated description of work at the Willard State Insane Asylum at Willard, N. Y. The noticeable features are the way in which the traps are made safe against syphonage and the treatment of the trap vent pipe system. 1200 w. Eng Rec—July 17, 1897. No. 14055.

BATHS.

Roman Baths. Illustrated description of some of these noted baths, with the customs of the people who used them. 2000 w. Sci Am—July 10, 1897. No. 13908.

LEAD.

Lead. A defense of lead work as used by the plumber, and some of the physical and chemical properties of the metal are given in part first. 1500 w. Dom Engng—July, 1897. Serial. 1st part. No. 14232 C.

PEPPERMINT Test.

Back Vent Connections and the Peppermint Test in Boston. James J. Lawler. Comment on the requirements of the sanitary inspector, growing out of the use of the peppermint test, and suggesting the use of the smoke test in its stead. 800 w. Dom Engng—July, 1897. No. 14231 C.

Preparation for Peppermint Test. Suggestions for arrangements in construction which will permit frequent testing, with directions fo making this test which is in most general use Ill. 600 w. Dom Engng—July, 1897. No 14230 C.

PLUMBING.

Plumbing in the Commercial Cable Building. Illustrated description of the water-supply system. 1600 w. Eng Rec—July 3, 1897. No. 13882.

SANITATION.

American Household Sanitary Appliances. (Ausgeführte Beispiele von Amerikanischen Haus Entwasserungs-Anlagen.) W. P. Gerhard. An excellent description of American bath room plumbing, for the benefit of German readers 5000 w Gesundheits Ingenieur—July 15, 1897. No. 14168 B.

Plumbing and Sanitary Work. S. S. Hellyer. Read before the Architectural Assn., England. Part first discusses plumbing practice in England, with remarks on cost. Ill. 3500 w. Plumb & Dec—July 1, 1897. Serial. 1st part. No. 13984 A.

MISCELLANY.

ARBITRATIONS.
The Practice of Arbitrations. Review by Prof. Kerr, of a work entitled "The Law Relating to Civil Engineers, Architects, and Contractors; with a Chapter on Arbitrations," by L. Livingston Macassey. Considers only the practice of building arbitrations. 4800 w. Jour Roy Inst of Brit Archs—June 17, 1897. No. 14082 A.

BELGIUM.
Belgium: Its History, Art, and Social Life. William Elliot Griffis. An interesting account of this country, with illustrations of the architecture. Ill. 3300 w. Chau—Aug., 1897. No. 14340 C.

BRICK.
Brick versus Wood. R. Clipston Sturgis. The writer proposes to treat briefly, first, the advantages of brick over wood; second, the adaptability of brick to all circumstances of climate and all classes of buildings; and third, a consideration of the means for promoting the more general use of brick. 2000 w. Br Build—July, 1897. Serial. 1st part. No. 14292 C.

BROWNSTONES.
General Features of Brownstones. T. C. Hopkins, in Appendix to the annual report of Pennsylvania State College. Part first gives the chemical composition, structural features, and analysis. 3500 w. Stone—July, 1897. No. 14210 C.

CEILINGS.
Ceilings and Their Decoration. Walter J. Pearce. Suggestions for the treatment of ceilings, with illustrations of designs for stencilling are given in part first. 2500 w. Plumb & Dec—July 1, 1897. Serial. 1st part. No. 13985 A.

COMPETITIONS.
See same title under Economics and Industry, Governmental Control.

CYCLONE.
The Cyclone of June 18. (Le Cyclone du 18 Juin.) An account of the damage done in the vicinity of Paris, with a suggestion as to the imbedding of metal in masonry, in order to resist sudden tensional stresses. 1500 w. Revue Technique—July 10, 1897. No 14142 D.

DERBY, England.
The Architecture of Our Large Provincial Towns. Historical account of this ancient town and its architecture. It has no great building but there is much of interest both old and new. Ill. 3800 w. Builder—July 17, 1897. No. 14254 A.

DRAUGHTSMANSHIP.
Fifty Years of Architectural Draughtsmanship. R. Shekleton Balfour. Comments on the collection of architectural drawings and designs recently on view in the rooms of the Royal Institute. 2200 w. Jour Roy Inst of Brit Archs—June 17, 1897. No. 14083 A.

ENTASIS.
A Discovery of the Entasis in Mediæval Italian Architecture. William H. Goodyear. A study of entasis as employed in columnar and other forms, and explanations of the purpose as given by various writers. Numerous examples are given, and many illustrations. 8000 w. Arch Rec—July-Sept., 1897. Serial. 1st part. No. 14226 C.

INSPECTION.
Building Inspection in New York City. An instance of a building showing signs of weakness is given, that having been strengthened by experienced contractors, proved on inspection, to be worse than at first. Cited as a proof of the necessity of inspection work. 500 w. Eng Rec—July 24, 1897. No. 14276.

MATERIAL.
The Influence of Material on Architecture. Banister F. Fletcher. Prize essay, written for the Inst. of Architects in 1896. Republished as a good résumé of an important aspect of architectural study. Part first consists of introduction; Chap. I. on Egypt: Mud and Reeds to Granite; and Chap. II. on Assyria: Mud to Brick, or Wood to Stone. 2800 w. Builder—July 24, 1897. Serial. 1st part. No. 14420 A.

NON-FLAMMABLE.
See same title under Marine Engineering.

SUMMER School.
An Architectural "Summer School" Abroad. E. B. Homer. An account of the first part of the trip of architectural students who crossed the Atlantic for one thousand miles of bicycle travel in Europe, for the opportunity of architectural study. Ill. 2000 w. Am Arch—July 31, 1897. Serial. 1st part. No. 14416.

TECHNICAL Education.
Technical Education in Architecture and the Building Trades. W. R. Lethaby. Read before the International Congress on Technical Education. Defines architecture and style, reviews the past, and suggests that the unions take up the work of teaching architecture and building. 3800 w. Jour Soc of Arts—July 23, 1897. No. 14396 A.

TEMPLES.
Structural Temples. Cyrus K. Porter. Describes the ancient temples of Egypt, the temple of Jerusalem, the temples of ancient Greece and Rome, the temples of Baalbec, &c. 7000 w. Stone—July 1897. No. 14209 C.

VILLENEUVE.
Villeneuve-les-Avignon. A brief description of the architectural curiosities of this old town in the south of France. Ill. 2400 w. Builder—July 10, 1897. No. 14064 A.

WORKMEN'S Homes.
The Housing of the Working Classes. Dr. Beveridge. Read before the Sanitary Inspectors of Scotland. The difficulties encountered and overcome in Aberdeen. Confined principally to a consideration of air space. 1700 w. San Rec—July 23, 1897. Serial. 1st part. No. 14399 A.

WREN'S Buildings.
Sir Christopher Wren's Buildings. Gives the most complete list of them as prepared by James Elmes. 4200 w. Arch, Lond—June 25, 1897. No. 13871 A.

CIVIL ENGINEERING.

BRIDGES.

ARCHES.

The Iron Arch over the Döblinger Hauptstrasse. (Die eiserne Bogenbrücke über die Döblinger Hauptstrasse.) Carl Stöckl. Description and full analytical investigation of 110 ft. span wrought iron arch on the belt line of the Vienna elevated railway. Two articles, plates of details. 7500 w. Zeitscher d Oesterr Ing u Arch Ver—June 25, July 2, 1897. No. 14115 E.

Trussed Arches with Reduced Horizontal Thrust. (Bogenträger mit Verminderten Horizontalschube.) Prof. J. Melan. Showing arrangements for counter weighting each half of the span, thus making a partial cantilever construction. 1 plate 3500 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14154 D.

BRIDGE Operation.

See same title under Electrical Engineering, Power.

BRIDGE Renewing.

See same title under Railroad Affairs, Maintenance of Way.

CHANNELS.

The Natural Width of River Channels. Observations to determine to what extent the contraction of the waterway at a bridge site may be carried. 1100 w. Ind Engng—June 12, 1897. No. 14089 D.

COLUMBIA Bridge.

See same title under Railroad Affairs, Maintenance of Way.

DRAWBRIDGE.

Third Avenue Drawbridge Across the Harlem River, New York City. Illustrated description of this massive drawbridge. 1500 w. Sci Am—July 17, 1897. No. 14013.

EQUALIZING Gear.

Equalizing Gear for Operating Machinery of a 246½-Ft. Swing Bridge, Chicago, Ill. Describes and illustrates a novel and effective departure in applying the power for the operation of a swing bridge. 500 w. Eng News—July 8, 1897. No. 13950.

GIRDER Bridges.

Standard Plans for 100-Ft. Through Plate-Lattice Girder Bridges; Northern Pacific Ry. Considerations that led to the adoption of this type, and the advantages in its favor. Illustrated description. 1000 w. Eng News—July 8, 1897. No. 13946.

Plate-Lattice Girder Bridge Over Little Missouri River, Northern Pacific Railway. Illustrates standard designs prepared by Mr. K. E. Hilgard, for 100-ft. deck plate girders and 85-ft. through plate-lattice girders, with details. Also describes the most recently built bridge of this type. 1300 w. Eng News—July 15, 1897. No. 14022.

HARLEM Bridge.

Piers and Abutments of the Harlem Ship Canal Bridge. An interesting illustrated description of masonry and caisson construction. 1200 w. Eng Rec—July 24, 1897. No. 14274.

PAINTING.

Painting Metal Bridges. William B. Mackenzie. Results of experiments of the writer are given, and much valuable information. 3500 w. Can Eng—July, 1897. No. 13994.

Paint Tests. Max Goltz. Recommendations, based on study and careful examinations, for painting iron and steel bridges, and other metallic structures. Also discussion. 5500 w. Jour Assn of Engng Soc—June, 1897. No. 14298 C.

REDHEUGH Bridge.

The Redheugh Bridge. Illustrated description of the characteristics of a bridge soon to be rebuilt. The remarkable feature is that the upper and lower members of the girders are respectively gas and water mains. 2200 w. Eng, Lond—July 9, 1897. No. 14057 A.

STREET Railway Bridges.

See same title under Street and Electric Railways.

SWING Bridge.

See same title under Railroad Affairs, Maintenance of Way.

TRUSS Design.

A New Truss Design and Its Analysis. C. L. Strobel. Design, including strain sheet, worked out so as to show the proportioning of parts and the weights and cost, prepared by the writer in connection with the competition for the Sixth St. bridge, Pittsburg, Pa. 1300 w. Eng News—July 22, 1897. No. 14238.

Stresses in Lattice Members in a Parabolic Truss. (Einflusslimen für die Spannungen der Gitterstäbe berin Parabelträger.) Emil Bittner. An analytical investigation for various loads. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—July 16, 1897. No. 14119 B.

VICTORIA Bridge.

The Victoria Bridge, Colombo. Charles Vincent Bellamy. Reasons for removing the Bridge of Boats and for the building of a new structure, with description and information. Ill. 9400 w. Ind & East Eng—June 26, 1897. No. 14293 D.

CANALS, RIVERS AND HARBORS.

CANAL Improvement.

Canal Improvement to Date. Herschel Roberts. Progress of the work under the nine million dollar expenditure. Contracts now under way. Contracts about to be let. Statement of advancement. 4000 w. Sea—July 8, 1897. No. 13923.

CHEZY Formula.

On the origin of the Chézy Formula. $V = c\sqrt{rs}$. Clemens Herschel. A translation of as much of the original Canal de l'Yvette report as refers to the formula in question. Believed to be for the first time printed. 2300 w. Jour Assn of Engng Soc—June, 1897. No. 14299 C.

DEEP-WATER Canals.

Proposed Deep-Water Canals in Germany and Austria. W. Powell. Consular report of the proposed enlargement of the waterway between Stettin and Berlin and other projects. 500 w. Prac Eng—July 9, 1897. No. 14068 A.

DREDGES.

Bucket and Suction Dredge. (Seebagger mit Erinern und Saugrohr.) An illustrated descrip-

tion of the powerful dredge built by Smulders, of Rotterdam for the Russian government for use in the sea of Azov. 1000 w. 1 plate. Zeitschr d Ver deutscher Ing—July 3, 1897. No. 14105 B.

New Hydraulic Dredges for the Mississippi River Improvement. Illustrated detailed description of dredges designed for low water use, where there is no hard material. The rotary cutters have been omitted and powerful water jets are adopted for stirring up the material to be excavated. 2000 w. Eng News—July 22, 1897. No. 14242.

FLOODS.

See same title under Railroad Affairs, Miscellany.

HYDRODYNAMICS.

A General Theory of the Laws of Vortex Motion in Liquids. (Théorié Générale des Régimes Graduellement Variés dans l'Écoulement Tourbillonant des Liquides.) J. Boussinesq. A highly mathematical treatment of the subject, deriving the first approximative formulas. 2500 w. Comptes Rendus—June 8, 1897. No. 14121 D.

Experimental Verification of the Theory of Gradually Varied Flow in Open Channels. (Vérification Experimentale de la Théorie de l'Écoulement Graduellement Varié dans les Canaux Découverts.) J. Boussinesq. Showing a very satisfactory agreement between the theoretical deductions and the experimental results. 3000 w. Comptes Rendus—June 14, 1897. No. 14125 D.

Expression for the Small Transversal Components of the Velocity. (Expression des Petites Composantes Transversale de la Vitesse.) M. Boussinesq. A further contribution to the mathematical theory of the gradually varied flow of liquids. 2500 w. Comptes Rendus—June 21, 1897. No. 14128 D.

The Distribution of Velocities in Large Cross Sections. (Distribution des Vitesses à Travers les Grandes Sections.) M. Boussinesq. A mathematical discussion, continuing the author's previous researches. 2500 w. Comptes Rendus—July 5, 1897. No. 14131 D.

ILLINOIS Streams.

The Streams of Illinois and Their Future Development. Eben J. Ward. Discusses the importance of the improvement of natural water courses, the favorable situation of Illinois, the connection of Lake Michigan and the Mississippi, cost., &c., with discussion. 7000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14204 D.

PANAMA.

The Present Condition of the Panama Canal. (Etat Actuel des Travaux du Canal de Panama.) Description, with photographs of the existing state of affairs along the line of the works. 3000 w. Revue Technique—June 10, 1897. No. 14133 D.

PROPOSED Harbor.

Proposed Harbor at Licata, Sicily. A. E. Carey. Gives a sketch of a scheme of importance both commercially and scientifically, with plan of the work and statement of existing conditions. Ill. 1300 w. Eng, Lond—July 9, 1897. No 14058 A.

RHONE Canal.

See Economics and Industry, Commerce and Trade.

RIVER Improvement.

The Regulation of the Elbe and the Saale. (Die Regulirung der Elbe und der Saale.) V. Witasek. With map of the lower Saale, and plan and sections of the dike on the Elbe near Magdeburg, and view of the movable dam at Pretzien. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 2, 1897. No. 14116 B.

VOLGA.

The River Volga. C. H. Moberly. The importance of the river as the great water highway of Russia, with a general description, to be followed with particulars of the several sections, and some account of the rise and development of the navigation. 3000 w. Engng—July 23, 1897. Serial. 1st part. No. 14365 A.

IRRIGATION.

WOODEN Pipe.

Submerged Wooden Pipe and Concrete Diverting Dam for the Rio Grande Dam and Irrigation Co. J. L. Campbell. Describes features of a comprehensive system of irrigation, which, if completed, will supply water to 300,000 acres of land. Ill. 2000 w. Eng News—July 15, 1897. No. 14018.

MISCELLANY.

ARCHES.

The Influence of Temperature Changes on Arches (Einfluss von Temperaturschwankungen auf Gewölbe.) J. Herrnanek. Analytical investigation of the stresses and distortions caused by temperature changes. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 2, 1897. No. 14117 B.

BEAM Dimensions.

Beam Dimensions and Load by Diagram. Henry Hess. Method is explained. 1500 w. Mach, N. Y—July, 1897. No. 13899.

CEMENTS.

Tests of Cements. Conclusions adopted by the French commission. Reprinted from the translation by O. M. Carter and E. A. Gieseler, and published by the War Department. 3500 w. Eng Rec—July 10, 1897. Serial. 1st part. No. 13954.

The Annual Meeting of the Association of German Portland Cement Manufacturers. Abstracted by S. B. Newberry. Report of the meeting including discussions, committee reports, etc., with editorial on the report concerning the action of sea water upon hydraulic cement. 7500 w. Eng News—July 29, 1897. No. 14332.

The German and English Portland Cement Industry. (Die Deutsche und die Englische Portland Zement-Industrie.) Hr. Kaemp. Giving a comparative view of the methods of manufacture, relative growth and value of the efforts of the association of German manufacturers. 3000 w. Zeitschr d Ver deutscher Ing—June 19, 1897. No. 14101 B.

COUNTRY Roads.

A Chapter on Country Roads. A paper by Wm. R. Hoag, on European Roads, presented before the Engs' Club of Minneapolis; a letter

by W. E. Curtis in the *Chicago Record*, stating what is being done by the government; brick and steel roadways, convict labor, etc., are discussed. 6500 w. Brick—July, 1897. No. 13830.

DAM.

Concrete Water-Power Dam at Rock Island Arsenal. Ill. Odus C. Horney. Illustrated description of the construction, and report of a series of tests of importance, also discussion. 6800 w. Jour W Soc of Engs—June, 1897. No. 14306 D.

DECIMAL System.

Decimal Division of the Hour. (Décimalisation de l'Heure.) A discussion of the propositions of the government commission as to the decimal sub-division of the hour and of the circle, by the Society of Civil Engineers of France. 1200 w. Revue Technique—July 10, 1897. No. 14146 D.

DRAINAGE.

Reclamation of the Tiber Marshes. Extract translation from *Gurnale del Genio Civile*, Dec., 1895, with three plans. Describes the delta of the Tiber and the district reclaimed, the work and the great improvement in the sanitary condition. 4200 w. Ind Engng—June 5, 1897. No. 13961 D.

Sluice Box and Flood Gate Construction; Fraser Valley Reclamation, British Columbia. R. E. Palmer. Extract from paper read before the Canadian Soc. of Civil Engs. Describes the design and construction. Ill. 1200 w. Eng News—July 22, 1897. No. 14241.

The Drainage of the Hackensack and Newark Tide Marshes. Plan for the redemption of this waste land as prepared by C. C. Vermeule. The method shuts out the tides by earthen embankments and drains off the water. 1600 w. Eng Rec—July 3, 1897. No. 13879.

Tile Draining in New England. H. N. Brooks. Presents some of the benefits of under draining and a few suggestions for laying drains. 1700 w. Brick—July, 1897. No. 13829.

ELECTRIC Boring.

See same title under Electrical Engineering, Power.

FRAMEWORKS.

Some Fundamental Propositions Relating to the Design of Frameworks. Frank H. Cilley. Discusses the arbitrary nature of the distribution of stress in an indeterminate framework and the economic superiority of statically determined construction. 8500 w. Tech Quar—June, 1897. No. 14283 F.

HIGHWAYS.

American Highways. Charles A. Bell. A résumé of a book by Nathaniel Southgate Shaler, giving intelligent guidance on this subject. 3300 w. Chau—July, 1897. No. 13888 C.

INTEGRATOR.

The Panintegrimeter, an Instrument for measuring Curves and Surfaces. (Panintégrimètre, Instrument pour Mesurer les Courbes et les Surfaces.) Describing the new integrator of Kohlmorgen, a combination of the pantagraph and the planimeter, and of much wider range of uses than the latter instrument. 2500 w. Revue Technique—July 10, 1897. No 14145 D.

MADAGASCAR.

Engineering Work in Madagascar. (Les Travaux du Génie a Madagascar.) Col. Fix. Giving an interesting account of the engineering work planned and partly executed by the French military engineers. Two articles, 5000 w. Revue Technique—June 10 & 25, 1897. No. 14136 F.

RECREATION Pier.

The New Recreation Pier, New York City. Illustrated description of the changes made in the pier at foot of East Third St., which is the first of four piers for recreation which have been projected. 600 w. Eng Rec—July 3, 1897. No. 13878.

SOCIETY House.

The Dedication of the Society House. (Die Feier der Weihe des Vereinshauser.) An account of the dedication ceremonies of the new house of the Society of German Engineers in Berlin, with illustrations of the building and details. 3000 w. Zeitschr der Ver deutscher Ing—June 26, 1897. No. 14102 B.

SUPERSTITIONS.

Traditions and Superstitions Regarding Public Works. Paul Sébillot. Part first consists of introductory remarks, and a chapter on the rites of construction of roads. 2500 w. Ry Mag—June, 1897. Serial. 1st part. No. 13933 C.

SURVEYING.

See Railroad Affairs, New Construction.

TUNNELS.

Electric Rotary Drills on Tunnel Work in France. Abstract from description in *Le Genie Civil* of a plant of the coal-mining company of Bouche-du-Rhone, France. The rock drills are operated by electric power generated by utilizing the water under pressure which is contained in the strata through which the heading is being driven. Ill. 1500 w. Eng News—July 22, 1897. No. 14239.

Guiding Tunnelling Shields. Harley H. Dalrymple-Hay. Remarks on the desirability of adopting some means of directing the course of a shield, with details of a system which has met with some measure of success in a recent example in the City and Waterloo Railway. Ill 2600 w. Ry Wld—July, 1897. No. 14074 A.

VIBRATIONS.

The Vibrations of a Beam under a Moving Load. (Die Schwingungen eines Trägers mit Bewegter Last.) A paper before the German Railway Society by Dr. Zimmermann, discussing the problem by the use of hyperbolic functions. 2500 w. Glaser's Annalen—June 15, 1897. No. 14156 D.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

AMERICAN Machinery.

The Outlook for American Machinery in Great Britain. A summary of recent inquiries among a number of representative dealers and manufacturers in Great Britain. 2700 w. Mach, N. Y.—Aug., 1897. No. 14374.

CHINA.

Revival of the Foreign Trade of China. Re-

port of active trade in both imports and exports. 2800 w. Bd of Trd Jour—July, 1897. No. 14309 A.

The Condition of Trade with China. Editorial calling attention to points in the results of an inquiry undertaken by Byron Brenan, the British Consul at Chefoo. 2500 w. Engng—July 9, 1897. No. 14043 A.

COMPETITION.

Competition—Is it Good or Evil? A. B. Richmond. Discusses what competition accomplishes, its evils and benefits, also co-operation. Generally favorable to competition. 1500 w. Tradesman—July 1, 1897. No. 13866.

CREDIT Protection.

Credit Protecting Unions in Germany. Extracts from the rules and regulations of the association, with other information. 900 w. Bd of Trd Jour—July, 1897. No. 14307 A.

EXHIBITION Warehouse.

First of American Exhibition Warehouses Abroad. Illustrated description of Warehouse being established at Caracas, Venezuela, with a view of stimulating trade. 500 w. Age of St—July 24, 1897. No. 14286.

FRANCE.

The Commerce and Manufactures of France. Yves Guyot. A sketch of the condition of the manufactures and commerce of France, which may be supported by authentic documents. 2200 w. Chau—Aug, 1897. No. 14338 C.

HARBOR.

See same title under Marine Engineering.

IRON Trade.

Progress of the Iron Trade in the Three Leading Countries of the World. Statistics of the production of pig iron in the United States, Great Britain and Germany. 1400 w. Eng News—July 29, 1897. No. 14334.

Statistics of the American Iron Trade for 1896. From the annual report of the American Iron and Steel Association. Interesting information of prices, shipments, consumption, exports, production, etc. 4800 w. Col Guard—June 25, 1897. No. 13836 A.

PATENTS.

Protection to Mechanical Industries. (Maschinen Fabrikauten und Schutzvorrichtungen.) K. Specht. Showing the insufficiency of the existing German patent laws, especially in view of the privileges of the government for the free use of inventions. 2500 w. Zeitschr d ver deutscher Ing—June 19, 1897. No. 14100 B.

PERSIA.

Our Trade with Persia. John Foster Fraser. Explains the cause of the violent fall in British trade with this country, and suggests a remedy. 2300 w. Contemporary Rev—July, 1897. No. 13972 D.

PRICES.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from April 1, 1893, to July 1, 1897. Covering the Period of Recent Extreme Depression. Tables. Bradstreet's—July 10, 1897. No. 13943.

Iron and Steel Prices in 1897. A review of the local iron and steel prices during the first half of the present year. Reports constantly lowering values. 1200 w. Am Mfr & Ir Wld—July 2, 1897. No. 13898.

PROTECTION.

A Broader Philosophy of Protection. Cephas Brainerd, Jr. A reply to article published in the July number, with presentation of the writer's views, and followed by editor's comments. 4500 w. Gunton's Mag—Aug, 1897. No. 14317 C.

RHONE Canal.

The Decadence of the Port of Marseilles and the Proposed Rhone Canal. Discusses the general decadence of French ports, and especially Marseilles, and M. Charles Roux's solution of the problem by connecting Marseilles with the Rhone and so give communication with all the canals and rivers of Europe. 1600 w. Bd of Trd Jour—July, 1897. No. 14306 A.

TARIFF.

Metals in the New Tariff. Provisions of the new tariff act in relation to metals, with comparison of duty under the late tariff. 900 w. Eng & Min Jour—July 31, 1897. No. 14387.

Tariff Changes and Customs Regulations. Russia, Denmark, Belgium, Netherlands, France, Portugal, Spain, Egypt, United States, Mexico, Argentine, China, Trinidad and Tobago. 5500 w. Bd of Trd Jour—July, 1897. No. 14310 A.

The Anatomy of the New Tariff. Charles A. Conant. Discusses the points of difference between the new tariff and the old, the increase of revenue, protection, the different articles most affected, and the attitude of foreign countries. 7000 w. Am Rev of Revs—Aug., 1897. No. 14392 C.

TIRE FABRICS.

The Position of the Tire-Fabrics Trade. Information relating to the output of the past year, prices, fabrics, etc. 1200 w. Ind Rub Wld—July 10, 1897. No. 14410 D.

TRADE Prospects.

A Turn in the Tide. Information from various points showing a general and wide-spread increase in consumptive request, and an encouraging outlook for fall trade. 3500 w. Bradstreet's—July 31, 1897. No. 14385.

TRADE Treaties.

England's Opportunity. Henry Birchenough. A discussion of the new Canadian policy, and the complications connected with it. The treaties of Belgium and Germany, and their bearing upon the question, with suggestion for solving the problem. 3800 w. Nineteenth Cent—July, 1897. No. 13997 D.

GOVERNMENT CONTROL.

ANTI TRUST Law.

The Decision on the New York Anti-Trust Law. Editorial on the decision of Judge Chester, holding certain sections of the Anti Trust law, passed by the New York Legislature, unconstitutional. 2800 w. R R Gaz—July 30, 1897. No. 14351.

COMPENSATION Bill.

The Workmen's Compensation Bill. C. A. Montague. Abstract of address before the London School of Economics. States the provisions of industrial insurance in Germany, and

the English bill is briefly discussed. 2000 w. Engng—July 9, 1897. No. 14046 A.

COMPETITIONS.

Regulations as to Government Competitions. Report for the enforcement of the Tarnsey Bill, as given in the Washington *Star*. 1500 w. Arch & Build—July 17, 1897. No. 14079.

JAPAN.

Japan's Patent Requirements. Information concerning the obtaining of patents in Japan furnish d by Jokichi Takamine. Illustration of patent office. 1800 w. Ry Rev—July 10, 1897. No. 13992.

LEGISLATION.

Labor Legislation. Editorial comment on the numerous enactments intended to protect the workman, and the questions now under consideration in England. 2400 w. Engng—July 23, 1897. No. 14367 A.

See Railroad Affairs, Miscellany.

LABOR.

ACCIDENTS Bill.

The Workman (Compensation for Accidents) Bill. Statement with regard to the provisions of the bill, prepared on behalf of the Mining Assn. of Gt. Britain, with account of the views of the Association as presented by a deputation sent to the Prime Minister. 6800 w. Col Guard—July 9, 1897. 14063 A.

BRITISH Workmen.

The British Workingman Under Victoria and Her Immediate Predecessors. Quotes the comments of different writers upon the causes of the prosperity which has characterized this period. 6000 w. Bul of Am Ir & St Assn—July 10, 1897. No. 13990.

EIGHT Hours Day.

Blast-Furnace Men and the Eight Hours Day. Editorial discussion of the complications that arise in considering the management of blast furnaces in this connection. 2300 w. Eng, Lond—July 16, 1897. No. 14261 A.

Blast-Furnace Men and the Eight Hours Day. Editorial presenting the conditions and the difficulties in solving the problem. 1800 w. Engng—July 9, 1897. No. 14044 A.

LABORING Classes.

Labor in the Victorian Age. Reflections on the improved condition of the laboring classes. 2000 w. Jour Gas Lgt—June 29, 1897. No. 13917 A.

LABOR-SAVING Machines.

Do Labor-Saving Machines Deprive Men of Labor? Carroll D. Wright. An interesting discussion of both views of the question, showing that impartial investigation has proved that every fact that seems to show that men have been deprived of labor, can be met by facts showing that more men have been supplied than deprived. 3000 w. Chau—Aug. 1, 1897. No. 14339 C.

STRIKES.

A Practical Remedy for Strikes. Presents the joint conference plan and discusses the advantages. Examples of the successful application of the system are given, and the method used by the Mason Builders Assn. of New York is explained. 3800 w. Gunton's Mag—Aug. 1897, No. 14316 C.

The Dispute in the Engineering Industry. Editorial comment on the present aspect of the strike in the engineering trade in England, to enforce the eight-hours day. 2900 w. Engng—July 16, 1897. No. 14251 A.

The Proposed Pittsburg Mining Agreement. The main points of the agreement which the operators are being asked to sign, in order to secure uniformity. 700 w. Am Mfr & Ir Wld—July 23, 1897. No. 14285.

The Threatened Strike. Editorial discuss on of the threatened strike of engineers, boiler makers and steam-engine makers, in England, to enforce an eight-hour day. 1600 w. Engng—July 2, 1897. No. 13966 A.

MISCELLANY.

AFRICA.

South Africa as a Land of Opportunities. Robert Wallace. Describing the characteristics and resources of the Transvaal and its inhabitants. 7000 w. Eng Mag—Aug. 1897. No. 14400 B.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

CARBORUNDUM.

A Product of the Electric Kiln. Interesting illustrated description of the Carborundum Company's Works, Niagara Falls, N. Y. 2000 w. Brick—July, 1897. No. 13828.

COLD.

Apparatus for the Production of Very Low Temperatures. (Apparat zur Herstellung sehr Niedriger Temperaturen.) A paper read before the convention of the German Electrochemical Association by Dr. Linde, describing the latest form of his apparatus for the liquefaction of air, and the fractional distillation of gases. 2000 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14173 B.

ELECTRO-Deposition.

Electro-Deposition and Recovery of Gold. E. Andreoli. Extract from paper read before the Society of Chemical Industry, London. Gives experiments made by the writer, and a chance discovery which led to a series of tests. 1000 w. Eng & Min Jour—July 24, 1897. No. 14234.

ELECTROLYSIS.

Electrolysis in the Manufacture of Raw Sugar. (Die Elektrolyse in Rohzuckerfabriken.) Gustav Schollmeyer. Describing the operation of the electrical diffusion apparatus used at the refinery at Unter-Berkowitz in Bohemia. 2500 w. Elektrochemische Zeitschr—July, 1897. No. 14177 B.

Methods and Apparatus for the Technical Electrolysis of Alkaline Chlorides. (Verfahren und Apparate zur Technischen Elektrolyse von Chloralkalien.) Leon Hulin. A practical paper based on the results of working experience. 3500 w. Elektrochemische Zeitschr—July, 1897. No. 14176 B.

Notes on the Quantitative Electrolysis of the Heavier Metals. (Beitrag zur Quantitativen Elektrolyse von Schwermetallen.) L. Wolman. Giving a number of methods, with full data as to solutions and currents. A prize essay at the Technical High School at Stuttgart. 4000 w. Zeitschr f Elektrochemie—June 20, 1897. No. 14171 B.

Quantitative Determination of Nitric Acid by Electrolysis. (Die Quantitative Bestimmung der Salpetersaüre durch Elektrolyse.) K. Ulsch. Tests upon known combinations show the method to be both accurate and convenient. 1200 w. Zeitschr f Elektrochemie—June 20, 1897. No. 14172 B.

FURNACE.

Electrical Furnaces. (Ueber Elektrische Oeferr). A paper before the convention of the German Electrochemical Association by Herr Pfleger, with discussion. Interesting data concerning the production of calcium carbid and other products are given. 4000 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14174 B.

LIGHTING.

ARC Circuits.

Switchboards and Station Instruments for Arc Circuits. Alex. Dow. Discusses switchboard construction and details, giving illustrations. 2300 w. Elec Engng—July 15, 1897. No. 14203.

BOLTON, England.

Electric Lighting at Bolton, England. Harold Lomas and Herbert C. Gunton. Illustrated description of a municipally controlled plant. 1800 w. Elec Wld—July 3, 1897. No. 13832.

COILS.

A New Form of Inductive Coil. Elihu Thomson. Describes a new type employing the principle of a "substitute primary" or "secondary primary." Ill. 1500 w. Trans Am Inst of Elec Engs—May, 1897. No. 13931 D.

CONDUCTORS.

The Computation of Conductors for Lighting on the Multiphase System. (Die Leitungsberechnung für Elektrische Beleuchtungsanlagen nach dem Drehstromsystem.) H. Cahen. Showing the best arrangement of conductors for any given system, with formulas and tables for practical use. Two articles. 4000 w. Elektrochemische Zeitschr—June 3 & 10, 1897. No. 14183 E.

DISTRIBUTION.

Distributing Systems. Abstracts of papers by J. A. Jeckell and J. R. Blaikie, read before the Municipal Electrical Assn., and followed by discussion. The merits of the various methods are presented, insulation discussed, and related matters. 3500 w. Eng, Lond—July 16, 1897. No. 14259 A.

ELECTRIC Fountain.

The Electric Fountain at Willow Grove, Philadelphia. Thornton B. Renwell. Illustrated detailed description. 2800 w. Am Elect'n—July, 1897. No. 13892.

GERMANY.

German Central Station Statistics. From the *Elektrotechnische Zeitschrift*. Recent statistics of German central stations giving a record of good work and affording an insight into the tendencies of electrical work in that country. 1200 w. Elec Eng—July 15, 1897. No. 14005.

HOSPITAL Lighting.

Electric Light Plant of the Columbus State Hospital. E. P. Roberts. States the conditions controlling the design, and gives illustrated detailed description. 1500 w. Am Elect'n—July, 1897. No. 13895.

INCANDESCENT Lamps.

The Spectrophotometry of Incandescent Lamps. W. R. Turnbull. Criticism of articles by Dr. W. H. Birchmore and M. A. Edson, with an effort to make clearer the composition of light from different sources, and the meaning of the term "luminosity." 1600 w. Elec Eng—July 8, 1897. No. 13916.

ISOLATED Plants.

Isolated Plants versus Central Stations. Percival Robert Moses. Analytical and classified comparison of results of the two methods, as observed in hotels, office buildings, etc. 3500 w. Eng Mag—Aug., 1897. Serial. 1st part. No. 14406 B.

LAMPS.

220 Volt Lamps. G. D. Shepardson. Abstract of paper read before the Northwestern Electrical Assn. Gives lamp tests and information relating to their life and efficiency, with favorable reports. 1800 w. Elec Eng—July 29, 1897. No. 14346.

LIGHTING Plant.

A Modern Central Station Plant. Frederick L. Ray. Illustrated detailed description of the plant of the Citizens' Electric Light and Power Company, Terre Haute, Ind. 4000 w. Am Elect'n—Aug., 1897. No. 14324.

A Small Lighting Plant for a City Building. Illustrated description of plant installed in the Art Club, Philadelphia. 900 w. Eng Rec—July 24, 1897. No. 14277.

The Hamilton, O., Municipal Plant. W. N. Gray. Remarks on the paper of W. W. Bean, and a correction of his statements in regard to city named. 1600 w. Elec Eng—July 8, 1897. No. 13914.

N. Y. LIFE Building.

See same title under Electrical Engineering, Power.

PORTOBELLO.

The Electric Lighting of Portobello, Edinburg. Report of Prof. Kennedy as prepared for the corporation. 1600 w. Arch, Lond—June 25, 1897. No. 13870 A.

RUSSIA.

Lighting Systems in Russia. M. Lutoslawski. Presents the state of affairs with respect to electric lighting in this country. 1800 w. Elec Wld—July 10, 1897. No. 13940.

SHOREDITCH.

Refuse and Light. Editorial approval of a combined electricity and dust destruction undertaking, with information concerning the plant. 2500 w. Engng—July 2, 1897. No 13965 A.

Shoreditch Electricity Works. Illustrated detailed description of buildings, refuse destructors and boilers, steam and exhaust pipes, generating plant, switchboards, public lighting,

mains, &c. 5200 w. Elec Eng, Lond—July 2, 1897. No. 13969 A.

STREET Lighting.

Public Street Lighting, by H. L. P. Boot; Street Lighting by Means of Rectifiers, by C. D. Taite; Street Lighting by Electricity, by S. E Fedden. Abstracts of three papers read before the Municipal Electrical Association, with discussion. 4000 w. Eng, Lond—July 9, 1897. No. 14060 A.

THREE-PHASE Systems.

Calculation of Lines for Three-Phase Lighting Systems. Hermann Cohen. Abstract of an article in the *Elektrotechnische Zeitschrift*, giving a discussion of this subject and the writer's conclusions. 1600 w. Elec Wld—July 10, 1897. No. 13941.

See same title under Power.

THREE-WIRE 440 Volt Plant.

The Three-Wire 440 Volt Plant of the Canton Electric Light Company. A. H. Perkins. An account of the difficulties and of the considerations that led to the adoption of this system. Ill. 1400 w. Elec Wld—July 10, 1897. No. 13942.

TRANSMISSION Plant.

See same title under Power.

VACUUM Tubes.

Moore Latest Vacuum Tube Lighting Apparatus. Illustrated description of apparatus. 300 w. Elec Eng—July 29, 1897. No. 14345.

VENEZUELA.

Electric Light Plant at Barquisimeto, Venezuela. (L'Installation de l'Éclairage Electrique de Barquisimeto, Venezuela.) Hydraulic power is used, with steam as an auxiliary in times of low water. Interesting effects were observed in the expansion of overhead wires in hot weather. 2000 w. Revue Technique—June 10, 1897. No. 14135 D.

POWER.

BOSTON Southern.

See same title under Railroad Affairs, Terminals and Yards.

BRIDGE Operation.

An Electrically Operated Bridge. J. E. Woodbridge. Describes and illustrates the interesting electrical features of the drawbridge connecting Duluth, Minn., and Superior, Wis. 700 w. Elec Wld—July 3, 1897. No. 13833.

CABS.

The New York Electric Hansom Cabs. Hugh Dolnar. Illustrated description of the hansom cab and its manner of operation, with success of the venture. 1300 w. Am Mach—July 8, 1897. No. 13920.

CONDENSER.

A Condenser System for Electric Power Plants. (Ueber ein Kondensator System für Elektrische Analagen.) Describing a form of independent steam condenser for use in connection with power plants where water is scarce. 2000 w. Deutsche Zeitschr f Electrotechnik—June 15, 1897. No. 14179 B.

DYNAMO.

Determination of the Excitation in Continuous Current Dynamos under Full Load. (Vorausbestimmung der Erregung bei Gleichstrom-dynamos für Vollbelastung.) Emil Dick. Giving analytical and graphical methods for use in the preliminary computations. 2000 w. Elektrotechnische Zeitschr — June 17, 1897. No. 14187. B.

DYNAMO Testing.

See same title under Mechanical Engineering, Engines and Motors.

ELECTRIC Boring.

Electric Boring Installation at Gardonne. M. H. Dubs, in the *Bulletin de la Société Scientifique Industrielle de Marseilles*. Describes the plant used in the construction of a sea canal. 900 w. Eng Rec—July 10, 1897. No. 13955.

ELECTRICAL Printing.

A Complete Electrical Printing Establishment. Illustrated description of the motor plant of the Lakeside Press building, Chicago. 900 w. W Elec—July 3, 1897. No. 13876.

ELECTRICAL Tests.

Power Required for Electrically Operated Wood-working Machinery. Report of tests made by O. G. Dodge at the navy yard at Washington, D. C. 1100 w. Sci Am Sup—July 31, 1897. No. 14296.

ELECTRICITY Works.

Electricity Works. S. T. Harrison. Reviews the conditions under which such works operate, and pointing out some of the difficulties tending to limit further decrease in price, under the present methods of working. 3200 w. Prac Eng —July 23, 1897. No. 14393 A.

INDUCTION Motor.

The Alternating Current Induction Motor. Charles Proteus Steinmetz. Discusses load curves, speed curves, regulation and stability. 7000 w. Trans Am Inst of Elec Engs—May, 1897. No. 13930 D.

MACHINE Driving.

Heavy Machinery Driven by Electric Motors. Illustrated description of power plant of the Farrel Foundry and Machine Co., at Ansonia, Conn. 600 w. R R Gaz—July 23, 1897. No. 14245.

MEASUREMENT.

A Compensator for Measurement of Tension and Volume of Current. (Ein Kompensator für Spannungs-und Strom Messungen.) R. Franke. A convenient rheostat apparatus, explained in diagram and shown also in actual form. 2500 w. Elektrotechnische Zeitschr—June 3, 1897. No. 14185 B.

Measurement of Alternating Current Power. A. F. McKissick. Directions for measuring single-phase, two-phase and three-phase circuits. Ill. 800 w. Am Elect'n—July, 1897. No. 13894.

NIAGARA.

Niagara Power. F. M. F. Cazin. The purpose of the paper is to discuss the features of power absorption from the falling waters as actually practiced, and to indicate a line for improved methods and machinery. 2200 w. Elec Wld—July 17, 1897. No. 14026.

N. Y. LIFE Building.

The Power and Lighting Plant of the New York Life Building. Illustrated detailed description of one of t e latest and finest of New York's office buildings, especially the

machinery plant. 2500 w. Elec Wld—July 10, 1897. No. 13938.

POWER Plant.

See Mining and Metallurgy, Coal and Coke.

See same title under Street and Electric Railways.

The Electrical Plant on the Sihl (Das Elektricitäts Werk an der Sihl.) Prof. Wyssling. A very full account of the hydraulic and electric plant near Zurich. Serial. Part I. 2500 w. Schweizerische Bauzeitung—June 12, 1897. No. 14148 B.

The Electric Plant of the Modern Tall Building. Frank A. Pattison. Suggestions as to boiler, steam piping, switchboard, storage battery, etc. 2300 w. Eng Mag—Aug. 1897. No. 14408 B.

SWITCH.

A New Automatic Switch. (Ueber einen Neuen Nebenschluss Automaten.) F. Collischonn. Describing and illustrating the author's improved automatic controller for widely varying loads. 2000 w. Elektrotechnische Zeitschr—June 24, 1897. No. 14188 B.

SWITCHBOARDS.

The Erection of Power Station Switchboards. George Moffat. Discusses the construction and the essentials to meet the requirements. Ill. 1800 w. St Ry Jour—July, 1897. No. 13858 D.

THREE-PHASE System.

Three-Phase Power and Light Plant at Liverpool. Illustrated description of a plant installed for the Liverpool Grain Storage and Transit Company at Bootle, Eng. 2500 w. Elec Rev, Lond—July 23, 1897. No. 14359 A.

TRANSMISSION Plant.

The Riverside Transmission Plant. W. A. Laymon. Illustrated description of an electric transmission and general distributing system for power and lighting. 1800 w. Min & Sci Pr—July 3, 1897. No. 13937.

TROLLEY-CARRIAGE.

A Trolley-Carriage to Run on Common Roads. Gilbert P. Coleman. Illustrated description of a motor carriage now in operation at Greenwich, Conn., which will probably lead to the establishing of a "trolley stage" line. 1300 w. Eng News—July 20, 1897. No. 14336.

TUNNELS.

See same title under Civil Engineering, Miscellany.

UNDERGROUND Mains.

The Localization of Faults in Underground Mains. Robert C. Quin. Discussion of methods and results of large experience. Read before the Municipal Electrical Assn. 1800 w. Elec Eng, Lond—July 23, 1897. Serial. 1st part. No. 14381 A.

WIMSHURST Machines.

Sectorless Wimshurst Machines. S. M. Keenan. Describes how to change a sectored to a sectorless machine, and also different machines constructed by the writer. 1500 w. Am Elect'n—Aug., 1897. No. 14328.

TELEGRAPHY AND TELEPHONY.

CABLES.

A new Recording Apparatus for Submarine Cables. (Sur un Nouvel Appareil Enregistreur pour Câbles Sous-marins.) M. Ader. The oscillations of a fine wire in a permanent magnetic field are photographically recorded. On the Marseilles-Algiers cable, 1600 signals per minute were recorded. 1200 w. Comptes Rendus—June 21, 1897. No. 14129 D.

Protection of Ocean Cables. Alexander Porter Moore. Abstract of communication to *New York Herald*. Reviews the efforts of the government to secure protection of the cables, and the need of wise legislation. 1500 w. W Elec—July 24, 1897. No. 14289.

The Working of Long Submarine Cables. R. M. Sayers and S. S. Grant. Read before a students' meeting of the Inst. of Elec. Engs. The difficulties in the working of cables exceeding 400 or 500 nautical miles in length. 1600 w. Elec Rev, Lond—July 9, 1897. Serial. 1st part. No. 14081 A.

COMMERCIAL Telegrams.

Delivery of Commercial Telegrams at Railway Stations. L. H. Korty. Read before the Assn. of Ry. Telegraph Supts., Niagara Falls, N. Y. Discusses irregularities of delivery, and how best to accomplish an improvement. 1300 w. Elec Rev—July 7, 1897. No. 13839.

FIRE Alarm.

Historical Sketch of the Fire Alarm Telegraph. Adam Bosch. The history of the development of this branch of telegraph work, from 1845 to the present. 7000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14214 D.

MARCONI System.

The Marconi System of Telegraphy. Additional information about the apparatus used in this system of telegraphy by electric waves. Ill. 2200 w. Elec Rev, Lond—July 16, 1897. No. 14266 A.

PATENT Infringement.

Complaint in the Suit Against the Bell Company for Patent Infringement. Complaint brought by the Western Telephone Construction Company of Chicago, alleging infringement of the Keelyn patent. Gives the bill of complaint. 1200 w. W Elec—July 3, 1897. No. 13877.

PRINTING Telegraph.

The Eaton Photographic Printing Telegraph. C. F. Eaton, Jr. Describes an automatic instrument in which the printing is done by the aid of light and instantaneous photography. 1000 w. Elec Eng—July 8, 1897. No. 13912.

PRIVATE Telephones.

Private Telephone Construction. F. H. Smith. Confined to the systems where no switchboard is used, together with the system with two or more instruments on one circuit. 1500 w. Elec Eng—July 8, 1897. Serial. 1st part. No. 13913.

RECEIVERS.

The Polarizing Telephone Receiver. (Das Polarisiren Telephonischer Empfänger.) J. W. Giltay. Describing the author's form of receiver in which the feeble tone is reinforced by use of a condenser. 3000 w. Electrotechnische Zeitschr—June 10, 1897. No. 14186 B.

The Polarizing of Telephone Receivers. J. W. Giltay. Translated from the *Elektrotechnische Zeitschrift*. An account of experiments and their results, with explanation of observed

phenomena. 3300 w. Elect'n—July 23, 1897. No. 14411 A.

SUBMARINE Telegraphy.
A New System of Submarine Telegraphy. Describes the principal features of an apparatus for the sending and receiving of telegraphic signals on long lines of cable, presented by Charles G. Burke. Ill. 1100 w. Eng News—July 22, 1897. No. 1424C.

SYNCHRONOGRAPH.
The Synchronograph. Discussion of paper on this subject, by A. C. Crehore and G. O. Squier. 16000 w. Trans Am Inst of Elec Engs—May, 1897. No. 13928 D.

TELEPHONE Dispatching.
The Telephone Dispatching System of the Akron, Bedford & Cleveland Railroad. F. J. J. Sloat. Describes the system that has been very advantageous under the conditions existing on this road. Ill. 1100 w. St Ry Jour—July, 1897. No. 13856 D.

TELEPHONE System.
The Telephone System of the United Kingdom. F. Charles Raphael. Part first gives the early history with illustrated description of the instruments used. 1400 w. Elect'n—July 2, 1897. Serial. 1st part. No. 13962 A.

MISCELLANY.

ALTERNATORS.
The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator. W. E. Goldsborough. A series of experiments carried on in the electrical laboratories of Purdue University for the purpose of investigating this subject. Apparatus and method are described and results given. 9500 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14211 D.

ARMATURES.
Winding Drum Armatures. William Baxter, Jr. Illustrates and describes the usual means for winding drum armatures and also an apparatus designed by the writer, showing the advantages of the latter machine. 1200 w. Am Mach—July 29, 1897. No. 14318.

BOWLING GREEN Building.
The Electrical Features of the Bowling Green Building. Illustrated detailed description of construction and equipment. 5800 w. Elec Wld—July 17, 1897. No. 14025.

CAPILLARITY.
Some Electro-Capillary Researches. (Einige Kapillarelektrischer Versuche.) A demonstration by Dr. Nernst of a number of interesting electro-capillary phenomena, before the convention of the German Electrochemical Association. 1200 w. Zeitschr f Elektrochemie—July 5, 1897. No. 14175 B.

CARBON.
Electricity Direct from Carbon. J. H. Hellweg, Jr. Reviews briefly the history of this subject tracing progress to the present time, and gives investigations of the writer. The experimenters think they have proved the production of electricity from carbon direct. 3500 w. Elec Wld—July 24, 1897. No. 14273.

CIRCUIT Breakers.
The Testing of Automatic Magnetic Circuit Breakers. C. M. Clark and C. W. MacMullen. Illustrated description of method of experimenting, apparatus, results, &c. 1400 w. Elec Eng—July 15, 1897. Serial. 1st part. No. 14004.

COIL Winding.
See same title under Mechanical Engineering, Engines and Motors.

CONDENSERS.
Application of Hyperbolic Analysis to the Discharge of a Condenser. Alexander Macfarlane. Mathematical investigation. 2400 w. Trans Am Inst of Elec Engs—May, 1897. No. 13929 D.

COSTS.
What Electrical Energy Costs. Albert B. Herrick. Part first states the operation of the present usual method of determining cost, and in subsequent articles will present what he considers a proper system. 1600 w. Elec Eng—July 8, 1897. Serial. 1st part. No. 13915.

ELECTRICAL Apparatus.
Method of Testing the Magnetic Properties of Iron Used in the Manufacture of Electrical Apparatus. George Moffat. Remarks on the importance and usual methods, with description of instrument designed by the writer. 600 w. Am Mach—July 15, 1897. No. 14011.

ELECTRICAL Code.
National Electrical Code. Sketch prepared by the code committee of the National Conference on standard rules and the committee on press of the Underwriters' National Electric Association jointly. 3800 w. W Elec—July 17, 1897. No. 14049.

ELECTRICAL Effects.
Electrified Matter. Harry L. Tyler. Part first is introductory to a series of chapters aiming to make clear that the electrician has only to deal with a condition. The various methods of electrifying will be considered. 900 w. Elec—July 7, 1897. Serial. 1st part. No. 13922.

ELECTRICITY.
See same title under Marine Engineering.
The Uses of Electricity in Sanitariums and in the Practice of Medicine and Surgery. George H. Guy. Reviews the different applications of electricity in medical practice, with remarks on the degree of success. 3000 w. Chau—Aug, 1897. No. 14337 C.

ELECTRICITY and Magnetism.
A Physical Theory of Electricity and Magnetism. T. Proctor Hall. A theory aiming to supply a simple and easily apprehended physical view of electric and magnetic phenomena. 2000 w. Elec Wld—July 3, 1897. No. 13834.

ELECTRIC Oscillations.
On the Theory of Electric Oscillations in Mutually Inductive Circuits. Edwin J. Houston and A. E. Kennelly. An answer to a question of considerable theoretical importance. 1300 w. Elec Wld—July 10, 1897. No. 13939.

FREQUENCY.
Frequency Transformation. F. Jarvis Patten. Describes an apparatus in which the change in the rate of induction is obtained by a novel form of electro-magnetic motor, which, in conjunction with the currents of altered frequency, determines the degree of transformation. Ill. 1300 w. Elec Eng—July 22, 1897. No. 14217.

FUSES.

Circuit Breakers a Step Backwards in Electrical Progress. Harry H. Cutler. Favors the use of properly constructed fuses, with discussion of facts relating to their use. 2500 w. Am Elect'n—Aug., 1897. No. 14325.

The Design of a Reliable Fuse. J. E. Woodbridge. Discusses the causes of their unreliability and the remedy. 3000 w. Am Elect'n—Aug., 1897. No. 14326.

INDUCTANCE.

The Measurement of Inductance with the Sechommeter. H. N. Allen. An account of a defect found in the sechommeter and its removal, with a comparison of this method with the Rayleigh method of measuring inductance. 1800 w. Elect'n—July 16, 1897. No. 14271 A.

A Suggestion for the Construction of Induction Coils. George T. Hanchett. Practical suggestions for the improvement of these coils. 1200 w. Elec Wld—July 17, 1897. No. 14023.

Mercurial Interrupter for Powerful Induction Coils. (Interrupteur à Mercure pour les Fortes Bobines de Ruhmkorff.) M. Cornu. A note presented to the academy describing the new contact breaker of MM. Ducretet and Lejeune, by which violent sparking is avoided. 1000 w. Comptes Rendus—June 14, 1897. No. 14126 D.

INSULATION.

Armature and Commutator Insulation. William Baxter, Jr. Presents the advantages of double insulation. Ill. 1700 w. Am Mach—July 22, 1897. No. 14221.

The Effect of Heat on Insulating Materials. Putnam A. Bates and Walter C. Barnes. Tests made to determine the real facts. 2500 w. Trans Am Inst of Elec Engs—May, 1897. No. 13932 D.

Weston Voltmeter Resistance Curves. Describes tests of insulation resistance made with this instrument, and manner of deriving curves. 1700 w. Am Elect'n—Aug., 1897. No. 14327.

LIGHTNING.

Two Remarkable Lightning Strokes. (Zwei Bemerkenswerthe Blitzschläge.) In both cases tall factory chimneys without lightning rods were rent vertically, the lightning leaping down the line of iron steps built in the masonry. 1200 w. Elektrotechnische Zeitschr—June 3, 1897. No. 14184 B.

LIQUID Air.

Liquid Air as a Factor in Electrical Development. Elihu Thomson in the Boston *Herald*. Outlines a system worthy of examination by those interested in electrical development. 1000 w. Elec Eng—July 22, 1897. No. 14218.

METERS.

Electricity Meters. T. P. Wilmshurst. Considers the essential conditions of a perfect meter, and discusses some of the most important points. Paper read before the Municipal Electrical Assn. and followed by discussion. 5000 w. Elec Eng, Lond—July 9, 1897. No. 14087 A.

Electric Metering from the Station Standpoint. Caryl D. Haskins. Discusses the accuracy, durability and other essential qualities of meters, and the desirability of their use. 4000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14212 D.

Prepayment Meters. H. W. Couzens. Read before the Municipal Electrical Assn. Considers the essential features of a prepayment electricity meter, and endeavors to show that its adoption would open important fields for electric lighting. 3000 w. Elec Rev, Lond—July 16, 1897. No. 14268 A.

The New Aron Meter. A résumé of Dr. Aron's paper describing his new meter, with illustrations. 1700 w. Elec Eng, Lond—July 9, 1897. No. 14088 A.

NIKOLA TESLA.

Nikola Tesla, the Electrician. Charles Barnard. An account of his life and work. Ill. 2200 w. Chau—July, 1897. No. 13889 C.

POLE Line.

The Pole Line. Frederic A. C. Perrine. A study of the stresses sustained by a pole line. 4000 w. Elec Engng—July 15, 1897. No. 14202.

RONTGEN Rays.

A New Form of Cathode Discharge and the Production of X-Rays, Together with Some Notes on Diffraction. R. W. Wood. Presents a new method of producing the rays, with its advantage, and describes its behavior. 3300 w. Phys Rev—July, 1897. No. 13976 D.

Apparatus for Roentgen Work. E. A. Robins, in the Photogram. The construction of induction coils and other pieces of apparatus in connection with the production of X-Rays. Ill. 2700 w. Sci Am Sup—July 17, 1897. No. 14015.

Properties of Simple Cathode Rays. (Propriétés des Rayons Cathodiques Simples.) H. Deslandres. Note on investigations made at the Paris observatory, showing that simple cathode rays correspond to simple electric oscillations. 1500 w. Comptes Rendus—June 8, 1897. No. 14123 D.

Röntgen Ray Diffusion Phenomena. Elihu Thomson. Illustrated description of a tube designed by the writer for obtaining strong radiation, and the tests made with it. 900 w. Elec Rev, Lond—July 2, 1897. No. 13952 A.

The Action of the X-Rays on the Retina. (Action des Rayons X sur la Retine.) M. Bardet. Showing that a feeble action is experienced when ordinary light is excluded. 1000 w. Comptes Rendus—June 14, 1897. No. 14127 D.

SAFETY Regulations.

Report on the Dangers of Electrical Generation. Second interim report to the Home Department, of the committee appointed to inquire into and report upon certain dangerous trades, with editorial comment. 7500 w. Elect'n—July 16, 1897. No. 14270 A.

STAGE Use.

Electricity on the Stage. H. Bissing. Comments on the slow progress in adapting electricity to the stage, discusses the objections, and advocates the "bank of coils" in preference to the "individual coil" for traveling use. 1300 w. Elec Wld—July 3, 1897. No. 13831.

THE "FUJI."

See same title under Marine Engineering.

THERMO-ELECTRICITY.

A Dissertation on Thermo-Electricity. J. Warren. It is proposed to briefly describe and sum up the merits of the various types of ther-

mopiles and conclude with a discussion on the thermo-electric powers of various dissimilar metals and their alloys. 1500 w. Elec, Lond—July 23, 1897. Serial. 1st part. No. 14348 A.

TRAINING.

The Training of an Electrical Engineer. Suggestions for the acquiring of such knowledge as will prove most useful to workers in this field. 3200 w. Elec Rev, Lond—July 9, 1897. No. 14080 A.

WAVE Theory.

The Derivation of the Fundamental Laws of Electrodynamics from the Wave Theory. (Die Ableitung des Elektrodynamischen Grundgesetzes aus der Wellentheorie.) Rudolf Mewes. A brief mathematical discussion, based on the investigations of Crookes, Heitz, Mayer, and others. 3000 w. ˋˋie Elektrizität—June 19, 1897. No. 14182 B.

WIRING.

Municipal Aids to Wiring. Alfred H. Gibbings. Read before the Municipal Electrical Assn., at Manchester. A short paper, with discussion, presenting the advantage of encouraging the use of electricity. 3000 w. Elect'n—July 9, 1897. No. 14085 A.

MARINE ENGINEERING.

BOILERS AND ENGINES.

ANCIENT Ships.

Some Ships of the Ancients. George Henry Preble. Interesting information of remarkable vessels, including the Arc, the Alexandria, or Alexandrian, and others. 5200 w. Sci Am Sup—July 17, 1897. No. 14014.

BRITISH Navy.

The Queen's Navy, 1837-1897. Abridged from an article by A. Laird Clowes, contributed to the *English Illustrated Magazine*. The changes during the present reign are reviewed. Ill. 1600 w. Ill Car and Build—June 25, 1897. No. 13872 A.

CANADIAN Mail.

The New Canadian Mail Service. Editorial discussing the probabilities of success, and the choice of designs for vessels. 2000 w. Eng, Lond—July 2, 1897. No. 13971 A.

CRUISER.

The Spanish Armored Cruiser "Cristobal Colon." (Le Croiseur Cuirassé Espagnol "Cristobal Colon.") A description of this powerful addition to the Spanish navy, with photographs of the vessel and of her water tube boilers. 2500 w. Revue Technique—July 10, 1897. No. 14144 D.

United States Armored Cruiser Brooklyn Present at British Naval Review. Illustrated detailed description. 1300 w. Marine Engng—July, 1897. No. 13867 C.

DANISH Ferries.

Danish Steam Railway Ferries and Ice-Breaking Steamers. I. C. Tuxen Read at the International Congress of Naval Architects and Marine Engineers. Illustrated description of the special features of these vessels. 2800 w. Engng—July 16, 1897. No. 14252 A.

ELECTRICITY.

Electricity on Board Ship, Principles and Practice. William Baxter, Jr. Part first explains the relation of electricity and magnetism. Diagrams. 2400 w. Marine Engng—July, 1897. Serial. 1st part. No. 13869 C.

FERRY BOATS.

The New Pennsylvania Railroad Ferry-Boats. Illustrated description of the new double twin-screw ferry-boats built for the new service of this road. 1000 w. Sea—July 29, 1897. No. 14352.

HARBOR.

Windau, as the European Export Harbor of the Siberian Railway. (Windau, der Europpäische Exporthafen der Grossen Sibirischen Bahn.) A discussion of the advantages of this Baltic seaport as a terminus from which the exports from Siberia may be handled. 2000 w. Glaser's Annalen—July 15, 1897. No. 14161 D.

HULL Weights.

On Graphic Aid in Approximating Hull Weights. J. Johnson. Read at the International Congress of Naval Architects and Marine Engineers. Gives the system used by the writer and found to be satisfactory. 600 w. Engng—July 23, 1897. No. 14370 A.

LAUNCH.

A Vapor Hunting Launch. Illustrated description of a launch built for H. M. Birge, of Buffalo. 900 w. Sci Am—July 24, 1897. No. 14222.

LIGHTHOUSES.

Lighthouse Progress, 1887-1897. J. Kenward. In 1887 the writer prepared an article on the lighthouse work and progress covering the preceding fifty years. This article covers the past ten years, and both together will give a summary record of what has been attained during the Victorian era. 4000 w. Nature—July 22, 1897. No. 14384 A.

MATERIALS.

Improved Materials of Construction and Their Influence on Design. John Howard Biles. Read at the Inst. of Civil Engs. Engineering Conference. The materials discussed are nickel steel and aluminum as applied to ship design. 3000 w. Ind & Ir—July 16, 1897. No. 14280 A.

"MAYFLOWER."

The Log of the "Mayflower." Governor Bradford's lost "History of Plymouth Plantation." The chapters relating to the passage of the "Mayflower" and the first landing and settlement of the Pilgrims. 2200 w. McClure's Mag—July, 1897. No. 13845.

NAVAL Architecture.

Advances Made in the Mathematical Theory of Naval Architecture. Edward J. Reed. Read at the International Congress of Naval Architects and Marine Engineers. A summary of the progress since 1860. Part first deals with strains and the provisions to withstand them, and with stability. 6800 words. Eng, Lond—July 16, 1897. Serial. 1st part. No. 14262 A.

NAVAL Review.
Royal Naval Review. General remarks upon the review at Spithead, with illustrated descriptions of the battle ships of the first and second classes, and the first-class cruisers are given in part first. 14000 w. Ind & Ir—July 2, 1897. Serial. 1st part. No. 13975 A.

NAVIGATION.
The Second Convention of the German-Austrian-Hungarian Association for Inland Navigation. (Der II Verbandstag des Deutsch-Oesterreichisch-Ungarischen Verbandes für Binnenschiffahrt.) A full account of the recent discussion at Vienna of the inland waterways of central Europe, with a discussion of the plans for extension and improvement. An important paper. 20000 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1897. No. 14150 D.

NON-FLAMMABLE.
Non-Flammable Wood. Charles E. Ellis. Read at the International Congress of Naval Architects and Marine Engineers. The process is described and tests reported, with some discussion of the use of such wood in naval architecture. 2000 w. Engng—July 9, 1897. No. 14042 A.

ON Shipboard.
At Sea on the Atlantic. Henry Hall. A mental glimpse of a voyage to Europe, confined to the experience on shipboard. Ill. 2800 w. Chau—July, 1897. No. 13890 C.

PROGRESS.
The Progress of Marine Engineering. Albert J. Durston. Read at International Congress of Naval Architects and Marine Engineers. A review of the history and progress in the Royal Navy and Mercantile Marine from the foundation of the Institution of Naval Architects to the present date. 2400 w. Engng—July 9, 1897. Serial. 1st part. No. 14047 A.

PROPULSION.
High-Speed Screw Propellers. Sydney W. Barnaby. Read at the International Congress of Naval Architects and Marine Engineers. An explanation of the theory of the formation of cavities in water by screw propellers at high speeds. 2200 w. Engng—July 16, 1897. No. 14250 A.

Screw Propulsion. Editorial regretting that Mr. S. Barnaby's paper on "Cavitation" was not adequately discussed, with a criticism of the views set forth by the writer. 1500 w. Eng, Lond—July 23, 1897. No. 14395 A.

RESISTANCE.
Skin-Resistance. H. S. Hele-Shaw. Read at the International Congress of Naval Architects and Marine Engineers. Gives experiments on the nature of surface resistance in pipes and on ships. Apparatus used is described and results given. 4000 w. Engng—July 16, 1897. No. 14253 A.

SHAFTS.
Crank and Other Shafts Used in the Mercantile Marine. G. W. Manuel. Read at the International Congress of Naval Architects and Marine Engineers. Discusses the cause of some of the failures, giving results of experience. Ill. 2300 w. Ir & St Trds Jour—July 17, 1897. No. 14248 A.

SHIP Design.
The Practical Application of Model Experiments to Merchant Ship Design. Archibald Denny. Abstract of paper presented at the recent Engineering Conference, in London. Shows how tank experiments are practically applied, and their value. Brief report of discussion. 2500 w. Steamship—July, 1897. No. 13983 A.

SHIP Ventilation.
The "Boyle" System of Ship Ventilation. Illustrated detailed description. 800 w. Steamship—July, 1897. No. 13982 A.

SPITHEAD.
The Review at Spithead. A summary of the features of the fleet, the cruisers, gunboats, torpedo boats, training ships, &c., also the foreign war vessels and merchant steamers. Ill. 3000 w. Eng, Lond—June 25, 1897. No. 13848 A.

STEAMBOATS.
Early Steamboats on Western American Rivers. Cons. D. Millar. Historical review of steamer traffic on the Ohio and Mississippi. Ill. 4100 w. Eng Mag—Aug., 1897. No. 14404 B.

STEAMSHIP.
S. S. "Clan Macdonald." Illustrated description of a screw-steamer, the first of four sister "Turret" vessels building for a Glasgow Co. 2200 w. Eng's Gaz—July, 1897. No. 13924 A.

The Screw Steamers "Pointer" and "Spaniel." Illustrated description of two recently built coasting steamers, for service from the Clyde to Belfast, Liverpool, and Manchester. 1400 w. Engng—July 2, 1897. No. 13965 A.

THE "FUJI."
Electrical Equipment of the Fuji. Charles E. Grove. Reprint from the *Thames Ironworks Gazette*. Describes the electrical equipment of this Japanese warship in a way to indicate to general readers what the work is like. Ill. 2000 w. Elec Eng, Lond—July 16, 1897. No. 14269 A.

UNITED STATES Navy.
The Steam Navy of the United States. Review of book by Frank M. Bennett, treating of the growth of the steam war vessel of the United States, giving information obtained therefrom. 3000 w. Trans—July 9, 1897. No. 14050 A.

WARSHIPS.
The Progress of British Warships Design. P. H. Colomb. Discusses the changes in design, armament, speed and endurance, favoring the development of the torpedo vessel. 3500 w. N Am Rev—Aug., 1897. No. 14421 D.

WEBB Home.
A Ship-Builder's Dual Monument. Illustrated description and information concerning the academy and home for ship-builders, built and endowed by William H. Webb. 2300 w. Harper's Weekly—July 10, 1897. No. 13921.

YACHTS.
Some Notable Steam Yachts. Illustrated descriptions of the "Andria" and the "Mayflower," which have recently been built in Scotland for American owners. 900 w. Sci Am—July 10, 1897. No. 13907.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILERS.

Steam Boilers with the Dubian Circulating Pump. (Damp f Kessel mit Dubiamscher Rohrpumpe.) Describing a siphon pump arrangement for use with boilers to maintain a positive circulation, with illustrations and numerous tables of tests. 5000 w. Zeitschr d Ver deutscher Ing—July 10, 1897. No. 14111 B.

CARE of Boilers.

Boilers Taking Care of Themselves. How to Wash-Out Boilers. Henry J. Raps. Treats of locomotive boilers, their proper care and inspection while in service; how to make heavy repairs, etc. 2400 w. Loc Engng—July, 1897. No. 13842 C.

CONDENSER.

A Combined Surface Condenser and Water-Cooler. Illustrates and describes a new apparatus designed and patented by Edward F. White. 900 w. Eng News—July 8, 1897. No. 13949.

DRAFT.

Mechanical Draft. Walter B. Snow. The First of a series of articles of interest to all who have to do with steam generating plants. 2200 w. Mach, N. Y—Aug., 1897. Serial. 1st part. No. 14376.

ECONOMIZERS.

Boiler Tests at the Armour Packing Co., Kansas City, Kan., Showing Per cent. of Saving by Use of Economizers. F. G. Gashe. Tests of the plant known as "Boiler House, No. 5." There are three Stirling boilers, Class A, equipped with Johns' mechanical stokers. The object of the trials was to obtain a measure of the benefit from the application of the Green fuel economizer. 2200 w. Power—Aug., 1897. No. 14354.

FUEL.

Petroleum as Steam Engine Fuel. J. A. F. Aspinall. Read before the Inst. of Civ. Engs. England. Reviews the advantages and pronounces the only difficulty to be the question of supplying fuel at a reasonable price. 1300 w. Ir Age—July 8, 1897. No. 13891.

PRESSURE.

Reducing Pressure on Shell Boilers. From *The Locomotive.* An explanation of the rumors that shell boilers are liable to a speedy and gradually increasing reduction of allowable working pressure, with discussion of the change in methods and manufacture necessary to meet the tendency toward high pressures. 2400 w. Ir Trd Rev—July 8, 1897. No. 13951.

REPAIRS.

How Not to Make Heavy Repairs on Locomotive Boilers. Henry J. Raps. Discusses the causes of injury, and the importance of proper care of a boiler. 2500 w. Loc Engng—Aug., 1897. No. 14360 C.

SAFETY Valves.

Safety Valve Practice. W. H. Booth. Calling attention to the importance of pressure, and referring to some notes made sixteen years ago. 1100 w. Am Mach—July 15, 1897. No. 14009.

The Lever Safety Valve. C. A. Collett. Presents methods of finding the proper area for a lever safety valve orifice, as given by different authorities, and gives the writer's opinion that lever safety valves should be consigned to the scrap heap, and pop valves substituted. 2200 w. Am Elect'n—Aug., 1897. No. 14330.

STEAM.

The Generation of Steam. Two papers by John F. Snell and J. J. Steinitz, with discussion, as presented at the convention of the Municipal Electrical Assn., at Manchester, Eng. The first writer discusses the types of boilers in use, with details; the second writer considers the type of boiler, fuel, water, stoking, and boiler adjuncts. 8800 w. Elec Eng, Lond—July 2, 1897. No. 13970 A.

WATER.

The Chemistry of Water. George H. Pattison. Explains the chemical formula of water and studies each gas separately. 2000 w. Power—Aug., 1897. No. 14355.

COMPRESSED AIR.

AIR COMPRESSION.

Experiments on a Two-Stage Air Compressor. John Goodman. Contributed to the Inst. of Civ. Engs. Devoted to a description of tests and methods of reducing the results. Ill. 3200 w. Col Guard—July 23, 1897. No. 14363 A.

The Compression of Air by the Direct Action of Water. Herbert W. Umney. Read before the Society of Engineers. Presents an improved method of compressing air, suitable for adoption in the case of low water falls, and of less expense than by other means. 3300 w. Prac Eng—July 16, 1897. No. 14265 A.

EXPLOSIONS.

Compressed Air Explosions Caused by Ignition. A letter of inquiry from Henry Fisher, of Nottingham, Eng, with editorial reply concerning the cause. 1400 w. Compressed Air—July, 1897. No. 14300.

HAULAGE.

See same title under Railroad Affairs, Miscellany.

LIQUID Air.

See same title under Electrical Engineering, Miscellany.

PORTABLE Compressed Air.

Power of Portable Compressed Air. Frank Richards. Inquiry and reply concerning the use and cost of compressed air as a motive power. 1700 w. Am Mach—July 29, 1897. No. 14320.

USES.

Uses of Compressed Air. J. C. Ransom. Reviews the development of the past few years, and the future possibilities. 2200 w. Tradesman—July 15, 1897. No. 14071.

ENGINES AND MOTORS.

CLEARANCE Spaces.

Large Cylinder Clearance Spaces. Editorial aiming to show that practice which is unquestionably good for stationary engines may be entirely

wrong for locomotives. 1000 w. Loc Engng—July, 1897. No. 13844 C.

COIL Winding.

Magnet and Coil Winding. J. Mason Knox. Illustrates and describes the Varley Duplex Magnet Company's new automatic magnet and coil winder. 800 w. Elec Rev—July 7, 1897. No. 13838.

DYNAMO Testing.

Testing Dynamos. Part first discusses the indicator method. 1400 w. Am Elect'n—Aug., 1897. No. 14329.

ELECTRIC Machinery.

Efficiency of Dynamo-Electric Machinery. Alfred E. Wiener. A study of the electrical efficiency, commercial or net efficiency, efficiency of conversion, and weight efficiency and cost of dynamos. 2000 w. Am Elect'n—July, 1897. No. 13893.

GAS Engines.

Gas Engines. W. F. Kelly. Read before the Engineers' Club, Columbus, Ohio. Information concerning the efficiency, mechanical features, cost, use, &c. 3500 w. Am Gas Lght Jour—July 5, 1897. No. 13841.

HEAT MOTOR.

The Diesel Rational Heat Motor. (Diesel's Rationeller Wärmemotor.) A paper read before the recent meeting of the Society of German Engineers at Cassel, by Herr Rudolf Diesel, describing an improved petroleum motor of high efficiency. Two articles. 10000 w. Zeitschr d ver deutscher Ing—July 10 & 17, 1897. No. 14107 E.

MOTOR.

See same title under Street and Electric Railways.

PISTONS.

Diagrams of Piston Position, Velocity and Acceleration. Part first considers the mechanism of the steam engine, crank and connecting rod, piston position: exact formulæ. Mathematical discussion. 2500 w. Prac Eng—June 25, 1897. Serial. 1st part. No. 13846 A.

PUMPING Engines.

The Pumping Engines at the New High Bridge Pumping Station, New York City. An illustrated description of a modern high-pressure pumping plant. 700 w. Power—Aug., 1897. No. 14353.

STEAM.

Experiments on Superheated and Saturated Steam. From Inst. C. E.: Foreign Abstracts. Reports experiments on a Sulzer compound condensing steam engine at a cotton mill in Bavaria, undertaken to test the economy with the separately-fired Schwoerer superheater. 1300 w. Eng—July 10, 1897. No. 14056.

TURBINES.

Recent Turbines. (Neuere Turbinenanlagen.) A. Pfarr. Detailed descriptions of a number of important installations of vertical and horizontal turbines, with plate of details of the 7 foot turbine of the Girard type for the Cape Town electric plant. 7500 w. Zeitschr d ver deutscher Ing—July 10, 1897. No. 14108 B.

Steam Turbines. Some remarks on the three well known types of steam turbines, the Parsons, the Dow, and the De Laval, and their successful use in driving electrical machinery. Ill. 1500 w. St Ry Rev—July 15, 1897. No. 14099 C.

The Steam Turbine Engine. J. D. Bailie. Abstract of a paper read before the North Staffordshire Inst. of Min. & Mech Engs. Presents the advantages claimed for this type, and for the turbo-electric generator. 1300 w. Col. Guard—July 16, 1897. No. 14256 A.

The Use of Turbines with a Horizontal Shaft for Running Dynamos. From *Le Genie Civil*. Illustrated description of some special turbines designed for the running of dynamos. 1800 w. Sci Am Sup—July 10, 1897. No. 13909.

POWER AND TRANSMISSION.

CABLEWAY.

The Britts Landing Cable Hoist and Quarry R. D. Seymour. A successful illustration of one of the uses to which a cableway can be applied, with illustrated description of quarry and means of working it. Discussion follows. 4200 w. Jour W Soc of Engs—June, 1897. No. 14304 D.

CHARGES.

An Inexpensive Method of Determining Charges for Public Use of Large Streams, in a Measure Proportionate to the Amount of Water Used. F. H. Crandall. Describes the use of a small meter placed in a by-pass. 900 w. Jour N Eng Water Works Assn—June, 1897. No. 13864 F.

FLYWHEEL Explosion.

Flywheel Explosion at the Power House of the Tacoma Ry. Co, Tacoma, Wash. A. Mc L. Hawks. Description of accident which took place on July 11, 1897. Ill. 700 w. Eng News—July 29, 1897. No. 14333.

PIPING.

Piping for High-Pressure Steam-Power Plants. A description of the various kinds of pipe, fittings, valves and gaskets, with the well-known methods of making joints and some of the advantages and disadvantages of each. 3000 w. Power—Aug., 1897. No. 14356.

ROPEWAYS.

Wire-rope Transportation. Illustrated brief description of the two general classes of these aerial ropeways, and their advantages. 700 w. Ir & Coal Trds Rev—July 2, 1897. No. 13926 A.

SCOOP Wheel.

A New Scoop Wheel for Raising Water—Paul's System. (Neues Schöpfrad, System Paul, zur Entwässerung von Niederungen.) An example of one of the most recent forms of apparatus for raising large quantities of water over a low lift, as extensively used in Holland. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—June 18, 1897. No. 14114 B.

STEAM.

The Cost of Steam Power. Horatio A. Foster. Describes the methods pursued in testing the plants reported, with tabulated data of results and general information. 7000 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14215 D.

TRANSMISSION.

Rope Transmission. Staunton B. Peck. The paper does not consider wire rope, but discusses briefly the "English System," and more particularly the "American System." Ill. 12500 w.

Jour W Soc of Engs—June, 1897. No. 14305 D.

Shafts, Belts and Pulleys. W. Barnet Le Van. Directions and statements helpful in securing the best results. 2200 w. Eng, N. Y. —July 24, 1897. No. 14290.

WATER Power.

Water-Ram in the Supply Mains of Hydraulic Power Plants. John Richards. An account of some of the difficulties experienced on the Pacific coast in the development of water power under great heads, with editorial discussion. 4500 w. Eng News—July 8, 1897. No. 13947.

SHOP AND FOUNDRY.

BABBITT Metals.

Babbitt Metals. C. Vickers, in *Machinery*. Proportions for a number of alloys are given with general information. 700 w. Sci Am Sup —July 10, 1897. No. 13911.

BICYCLES.

An American Bicycle Manufactory. An illustrated detailed description of the Works of the Pope Company. 3300 w. Engng—July 16, 1897. Serial. 1st part. No. 14249 A.

BIG Guns.

Big Gun Manufacture. Henry A. Wiley. Describes the work as carried on at the United States naval gun factory at Washington, D. C. 2800 w. Age of St—July 3, 1897. No. 13837.

CHUCKS.

Split Chucks. Describes a holder for split chucks for any lathe. Ill. 900 w. Am Mach —July 22, 1897. No. 14220.

ELECTRICAL Apparatus.

See same title under Electrical Engineering, Miscellany.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. The new processes based on the use of the electric current. Ill. 3100 w. Eng Mag—Aug, 1897. Serial. 3d part. No. 14403 B.

FOUNDRY Chemistry.

Foundry Chemistry in Practice. Letter from foundry in the northwest, engaged in the manufacture of agricultural machinery. Details concerning the use made of chemical analysis. 800 w. Ir Trd Rev—July 29, 1897. No. 14347.

FOUNDRY Irons.

Comparative Fusibility of Foundry Irons. Thomas D. West. Read before the Pittsburg Foundrymen's Assn., June 28, 1897. A valuable paper giving experiments and results, with description of test cupola used. Also discussion. 3000 w. Ir Trd Rev—July 1, 1897. No. 13826.

GEARS.

A New Line of Automatic Gear Cutting Machines. Illustrated description of machines of the Brown & Sharpe Mfr. Co. 900 w. Am Mach—July 15, 1897. No. 14010.

Cox's Strength of Gears Computer. Illustrated description of an instrument for calculating the strength of toothed gears, with a set of tables for working out questions connected with gearing. 400 w. Am Mach—July 29, 1897. No. 14321.

Spur Gear Arithmetic. Arthur B. Babbitt. The object of the article is to explain in as clear a manner as possible the underlying principles of gearing, and give concise rules or formulæ for the solution of problems. 1200 w. Mach, N.Y.—July, 1897. Serial. 1st part. No. 13900.

MODERN Shops.

One of the Modern Shops. Illustrated description of the new shops of the Garvin Machine Co., at Spring and Varick streets, New York. 1300 w. Mach, N. Y.—July, 1897. No. 13901.

POWER.

The Care and Oversight of the Power Plant. T. Carpenter Smith. Hints to superintendents regarding the management of men and machinery. 3700 w. Eng Mag—Aug., 1897. No. 14405 B.

RIVET Holes.

Spacing Rivet Holes. John Randol. Describes the way this problem was solved by Mr. Aue, superintendent of the De La Vergne shops. Ill. 1300 w. Am Mach—July 22, 1897. No. 14219.

SAND-SIFTING.

New Patterns of Sand-Sifting Machinery. George D. Rice. Drawings and descriptions of several new styles, not patented. 800 w. Mach, N. Y.—July, 1897. No. 13902.

TOOLS.

Machine Tools at the Leipzig Exhibition 1897. (Werkzeugmaschinen in der Gewerbeausstellung zu Leipzig, 1897.) Hermann Fischer. The first instalment of a description of recent German machine tools. The Chemnitz makers have followed American models closely. Serial, Part 1. 5000 w. Zeitschr d Ver deutschr Ing —July 17, 1897. No. 14112 B.

Punching and Shearing Machines. From *Revue Industrielle*. Illustrated description of a combined punching and shearing machine, and a simple shearing tool for profiled iron and steel. 1000 w. Sci Am Sup—July 10, 1897. No. 13910.

The Working of Steel. (Ueber Stahlwechsel.) Hermann Fischer. Discussing especially modern machine tools for the rapid production of duplicate work in steel with sketches of details from the practice of various countries. 7500 w. Zeitschr d ver deutscher Ing—June 26, 1897. No. 14103 B.

WORKSHOPS.

Works Management. On the management of engineering workshops. General principles with some suggestions of detail. 2800 w. Engng—June 25, 1897. No. 13851 A.

MISCELLANY.

AEROPLANE.

Experiments with a Steam Aeroplane. (Expériences Faites avec un Aéroplane mû par la Vapeur.) MM. Tatin & Richet. An aeroplane propelled by steam, and weighing 72 pounds, travelled 450 feet in 7¼ seconds. 1000 w. Comptes Rendus—July 5, 1897. No. 14132 D.

ALUMINUM.

Aluminum in Knitting Machinery. George D. Rice. Information useful to knitting machine builders who wish to try this new metal. Ill. 800 w. Mach, N. Y.—Aug., 1897. No. 14375.

Tests of Utensils of Aluminum. (Essai des Utensiles en Aluminium.) M. Balland. Giving the results of chemical tests made upon the cooking utensils of aluminum supplied to the French Army. Comptus Rendus—June 8,1897. No. 14124 D.

AUTOMOBILE.

The Scott Automobile Carriage (Der Scott'sche Zug.) Illustrated description of the Scott steam traction carriage for regular train service. 2000 w. Oesterr Monatschr g d Oeffent Baudienst—July, 1897. No. 14155 D.

CARDBOARD.

Machines for Treating Paper. (Outillage qui Transforment le Papier.) An illustrated description of improved machines, principally for cutting, and embossing cardboard, &c. 1500 w. 1 plate. Revue Technique—June 10, 1897. No. 14134 D.

GAUGING.

The Gauging of Casks. (Du Jaugeage des Tonneaux.) D. Dujon. Discussing the existing formulas, and especially the gauging of partially filled casks both when on end and lying on the side. 2000 w. Revue Technique—July 10, 1897. No. 14147 D.

GIANT See-Saw.

. A Giant See-Saw, for the Tennessee Centennial Exposition, Nashville, Tenn. Gilbert P. Coleman. An illustrated description of an engineering novelty which the promoters aim to make as prominent as the Ferris wheel at Chicago. 700 w. Eng News—July 8, 1897. No. 13948.

HEAVY Guns.

Evolution of the Modern Heavy Gun. W. LeConte Stevens. Historical review of the progress in the construction of materials used in warfare; confined principally to the evolution of the cannon. Ill. 5800 w. Pop Sci M—June, 1877. No. 14423 D.

INDIA-RUBBER.

The Testing of India-Rubber Goods. Discusses the drawbacks to chemical analysis, and gives specific cases where physical tests were made to give a fair criterion of the quality without unfitting the articles for sale. 2000 w. Engng—July 23, 1897. No. 14369 A.

INVENTION.

Forecasting the Progress of Invention. William Baxter, Jr. Discusses the lines along which great development is expected, showing that the expectations in regard to some of them will never be accomplished, because they are impossible, and that others are not likely to be realized. 3500 w. Pop Sci M—July, 1897. No. 14424 D.

MEASUREMENTS.

The English and Metric Systems. Charles T. Porter. A defense of the English system, showing its convenient features and the inadaptibility of the metric system to many uses. 3500 w. Loc Engng—July, 1897. No. 13843 C.

PUMPING.

See same title under Municipal Engineering, Water Supply.

PUMPS.

About Suction Pumps. Remarks on the construction and functions of a steam pump, the suction pipe and its proper size. 1700 w. Bos Jour of Com—July 31, 1897. No. 14364.

The Design of Centrifugal Pumps. J. Richards. An article in two parts treating the subject from the standpoint of a practical builder and designer, and containing much valuable information. Ill. 4200 w. Eng. News—July 29, 1897. Serial. 1st part. No. 14335.

RIVETING.

Experiments on the Frictional Resistance of Riveted Joints. (Untersuchungen über den Reibungwiderstand von Nietverbindungen.) An account of the very important tests made in Holland by J. Schroeder Vander Kolk for the Dutch government, with many diagrams and details for various kinds of riveting under different conditions. Two valuable papers. 12000 w. Zeitschr d ver deutscher Ing—June 26, July 3, 1897. No. 14104 E.

SKETCHES.

The Art of Making Mechanical Sketches for Marine Engineers. C. W. MacCord. Part first shows the importance of a knowledge of the principles of mechanical drawing and gives some suggestions for free-hand sketches. 1000 w. Marine Engng—July, 1897. Serial. Part 1st. No. 13868 C.

TECHNICAL Education.

Reforms in the Organization of Technical Education. Silvanus P. Thompson. Suggests the need of getting rid of the wrong use of the term, the adaptation to the needs of the various industries, the development of breadth of view and capacity in those trained, the proper selection of subjects, &c. 28000 w. Jour Soc of Arts—July 23, 1897. No. 14397 A.

The Development of the Mechanical Engineer. (Zur Ausbildung der Maschinen-Ingenieure.) A symposium upon the subject of engineering education by members of the German Society of Mechanical Engineers, including the opinions of such men as Stambke, Leissner, von Borries, Vogel and others. 12000 w. Glaser's Annalen—July 1, 1897. No, 14158 D.

Theory and Practice in Trade Teaching. Philip Magnus. Paper read at the International Congress on Technical Education. A few suggestions for trade teaching, with consideration of the difficulties. 3800 w. Jour Soc of Arts—July 9, 1897. No. 14070 A.

TEXTILE Machinery.

The Textile Machinery at the Leipzig Exhibition, 1897. (Die Maschinen für die Textilindustrie auf der Gewerbeaustellung zu Leipzig, 1897.) G. Rohn. The first of a series of articles describing the progress of textile machinery in Saxony, as exhibited at Leipzig. Serial. Part 1. 3500 w. Zeitschr d ver deutscher Ing—July 10, 1897. No. 14109 B.

U. S. Machinery.

Prospects for United States Machinery in Belfast. Reply of Consul James B. Taney to inquiries relative to road building and earthmoving machinery. 1000 w. Cons Repts—July, 1897. No. 13927 D.

MINING AND METALLURGY.

COAL AND COKE.

ALABAMA.

Mineral Production of Alabama William M. Brewer. Comments on recent statistics of coal, coke and iron and information of the mines, production, etc. Am Mfr & Ir Wld—July 9, 1897. No. 13979.

BRITISH Coalfields.

Notes on British Coalfields. Part first is devoted to the Great Northern Coalfield, dealing principally with the geological features. 1500 w. Ir & Coal Trds Rev—June 25, 1897. Serial. 1st part. No. 13905 A.

COAL Producing.

Continental Coal-Producing Countries—Their Progress and Prospects. Part first discusses the production and consumption in France. 1000 w. Ir & Coal Trds Rev—July 9, 1897. Serial. 1st part. No. 14086 A.

COAL Seams.

A Geological Curiosity. H. N. Sims. An illustrated description of a peculiar split in the mammoth coal seam near Ashland, Pa. 700 w. Col Eng—July, 1897. No. 13999 C.

DUSTY Coals.

Separation of Dusty Coals. M. Parent. From a communication to the *Annales des Mines*. Describes appliances constructed at Anzin, on the German principle of forcing air into the mass of small coal to be washed, so as to draw off the dust by current. 1100 w. Col Guard—July 16, 1897. No. 14255 A.

EXPLOSIVES.

Government Apparatus for Testing Explosives to be Used in Coal Mines. James Ashworth. Details of an apparatus erected at Woolwich, Eng., for a series of experiments, and a comparison of this apparatus with those which have been used in past experiments. 1800 w. Col Guard—July 23, 1897. No. 14362 A.

FIREDAMP.

Sudden Outbursts of Firedamp and Measures for Avoiding Accidents. A record of facts which are of a nature to throw light on these phenomena, obtained from records of engineers who have specially studied the subject. 4000 w. Col Guard—July 9, 1897. No. 14062 A.

HUNGARY.

See same title under Miscellany.

OUTPUT.

End of the Control of the Output Scheme. Editorial comment on the proposal of the associated coal owners of South Wales to limit the output in order to obtain better prices. 1300 w. Eng, Lond—June 25, 1897. No. 13849 A.

POWER Plant.

The Test of a Coal-Mining Electric Power Plant. T. D. Phillips and J. G. Swain. Gives a series of tests made upon the electrical equipment of Shaft No. 1 of the Brazil Block Coal Co. of Brazil, Ind. The machine gave good results and proved well adapted to the work required. Ill. 3000 w. Elec Wld—July 24, 1897. No. 14272.

SCREENING.

Screening Plant at Mossbeath Colliery. Walter H. Mungall. Read before the Mining Inst. of Scotland. Illustrated description. 1300 w. Col Guard—July 2, 1897. No. 13974 A.

SOUTH WALES.

The Coal and Iron Industries of South Wales. Details of the chief coal and iron industries. Part first deals largely with the coal trade. Information of the docks, the resources, output, characteristics, methods of working, winding, &c. Ill. 16500 w. Ir & Coal Trds Rev—July 23, 1897. Serial. 1st part. No. 14383 A.

STRIKE.

See same title under Economics and Industry, Labor.

VENTILATING Fans.

Experiments Upon Propeller Ventilating Fans and Upon the Electric Motor Driving Them. William George Walker. Read before the Inst. of Mech. Engs. Full account of experiments with results. 5400 w. Eng, Lond—June 25, 1897. No. 13850 A.

COPPER.

ARIZONA.

An Arizona Copper Deposit. John F. Blandy. Brief description of what the writer considers a deposit of great economic value. 600 w. Eng & Min Jour—July 24, 1897. No. 14235.

GOLD AND SILVER.

ARIZONA Mines.

The Mineral Resources of Arizona. Thomas Tonge. Considering the territory by counties. Ill. 4100 w. Eng Mag—Aug. 1897. No. 14407 B.

ASSAYING.

Assaying of Gold and Silver. Jacob B. Eckfeldt. Part first describes the assaying of gold, as conducted at the U. S. Mint in Philadelphia. 1600 w. Min & Sci Pr—July 3, 1897. Serial. 1st part. No. 13935.

AUSTRALIA.

West Australian Gold Mining. C. E. Moreing's paper read before the London Inst. of Civ. Engs. A summary of the principal features of the gold fields of this region. 1300 w. Min & Sci Pr—July 3, 1897. No. 13936.

CALIFORNIA.

Condition of Gold Mining in California. Charles G. Yale. The change in the character and system of mining, the production, and the value of other minerals mined in this State. 1300 w. Min & Sci Pr—July 10, 1897. No. 14017.

CHLORINATION.

Practical Workings of Chlorination. Thomas G. Taylor, Jr. Describes the process as carried on at the Champion Mine at Nevada City. 2500 w. Min & Sci Pr—July 17, 1897. No. 14223.

COMSTOCK Lode.

The Situation in the Comstock Deep Levels. Dan de Quille. Comment on the false impressions that seem to prevail regarding this mine,

and an outline of the work soon to be undertaken, with the hopeful outlook. 3000 w. Min & Sci Pr—July 10, 1897. No. 14016.

CYANID.

New Cyaniding Plants at Mercur, Utah. An account of two important new plants soon to be put up. 900 w. Eng & Min Jour—July 31, 1897. No. 14390.

Professor Christy on Cyanid. W. Bettel. A review of S. B. Christy's paper on "The Solution and Precipitation of the Cyanid of Gold." A severe criticism. 3800 w. Reprint from So African Min Jour—May 8, 1897. No. 14301 B.

DEPOSITS.

The Mineral Formation of the Golden Leaf Mines. Robert W. Barrell. Describes an unusual formation in southwestern Montana. 1600 w. Eng & Min Jour—July 17, 1897. No. 14039.

ELECTRO Deposition.

See same title under Electrical Engineering, Electro-Chemistry and Metallurgy.

GOLD Yield.

The Gold Yield of 1896. An American view claiming increase in production and great activity in gold-mining. 1400 w. Aust Min Stand—May 27, 1897. No. 13885 B.

GRAVEL Washing.

Gold Gravel Washing in Eastern Siberia. E. D. Levat. Illustrated description of the sluices in the placers worked by the Zeya Company. 900 w. Aust Min Stand—June 3, 1897. No. 13887 B.

KLONDIKE.

The Alaskan Gold Discoveries. Remarks on the effect of the recent discoveries both on the financial markets and speculation. Mention of the difficulties to be faced in reaching the region is made, and of the severe life due to the climate. 1000 w. Bradstreet's—July 31, 1897. No. 14386.

The Alaskan Placers. Brief account of the new discoveries, the routes by which to reach the Klondike fields, the mines so far discovered, and the dangers and hardships of the region. 1800 w. Min & Sci Pr—July 24, 1897. No. 14314.

The Gold Finds of Alaska. Words of caution regarding investments, with some information of the country, the deposits, and the products. 2500 w. West Min Wld—July 24, 1897. No. 14284.

The Klondike Gold Fields. Brief account of location, climatic conditions, ways of reaching the gold fields, method of mining, &c. 1000 w. Sci Am Sup—July 31, 1897. No. 14297.

The Yukon Gold Excitement. Presents facts leading to the belief that the Klondike is a very rich placer gold deposit, also giving information of the country, the climate, cost of transportation, and the attitude of the Canadian government. Short editorial also given. 1800 w. Eng & Min Jour—July 31, 1897. No. 14389.

LOW GRADE Ores.

The Concentration of Low Grade Ores. Edmund B. Kirby. Read before the International Gold Mining Convention. Reference is made to the various processes and their application to different grades of ore; the history of ore concentration and the improvements made it in are reviewed; the four different systems noticed, etc. Min Ind & Rev—July 15, 1897. Serial 1st part. No. 14090.

MERCUR, Utah.

Gold Mining in Mercur, Utah. John Dern. Condensation of a paper read at the International Mining convention at Denver, Colo. The history of the camp, its failures and success made possible by the application of cyanide. 2000 w. Min & Sci Pr—July 24, 1897. No. 14313.

MEXICO.

Notes on Mining in Oaxaca, Mexico. Maurice Clark. Reports concerning the three mining districts of this state, and pronounces it one of the most favorable fields in Mexico. 2200 w. Eng & Min Jour—July 10, 1897. No. 13988.

PLACERS.

Placer Mining. Gives calculations made to estimate the plan of working a placer, and the value and future of the same, as an illustration of the correctness. 2200 w. Min Ind & Rev—July 8, 1897. No. 13996.

PRODUCTION.

The Production of Gold in the United States in 1896 and the Mint Reports. Explains the discrepancy between the figures as reported by this journal and those of the Director of the Mint. 1800 w. Eng & Min Jour—June 17, 1897. No. 13987.

SILVER Mine.

The North Star Silver Mine. An account of valuable property in British Columbia. Ill. 1300 w. Can Min Rev—July, 1897. No. 14379 B.

SLIMES.

The Reduction of Zinc-Gold Slimes. E. H. Johnson. Notes read at the annual meeting of the Chemical and Metallurgical Society of S. Africa, describing the writer's own methods. 1200 w. S African Min Jour—June 19, 1897. No. 14302 B.

SMELTING.

The Present Status of Pyritic Smelting. Herbert Lang. Explanation of the reasons for abandoning the process at Keswick, and a defense of the process. 2500 w. Eng & Min Jour—July 10, 1897. No. 13989.

TASMANIA.

The Lefroy Goldfields (Tas.) A. Montgomery. Describes the geology, deposits, &c., in part first. 3500 w. Aust Min Stand—June 10, 1897. Serial. 1st part. No. 14291 B.

VEINS.

Vein Walls. T. A. Rickard. Abridged from a paper read before the Am. Inst. of Min. Engs. Interesting illustrated description of some typical formations as shown in the mining fields of western America. 3800 w. Col Eng—July, 1897. Serial. 1st part. No. 13998 C.

IRON AND STEEL.

ALABAMA.

See same title under Coal and Coke.

BLAST Furnaces.

Blast Furnaces, July 1, 1897. Showing the condition of blast furnaces of the United States at this date. Tables. Am Mfr & Ir Wld—July 16, 1897. No. 14069.

COLONIAL Ironworks.

Colonial Ironworks in 1731 and Afterwards.

Historical account of the industry in this country in colonial times. 1500 w. Bul Am Ir & Steel Assn—July 20, 1897. No. 14224.

COOLING.

The Influence of Sudden Cooling on Nearly Pure Iron. J. O. Arnold. Criticises statements and experiments of H. Marion Howe, and report of experiments by the writer, with results. 1300 w. Engng—July 9, 1897. No. 14045 A.

IRON Mine.

An Unusual Piece of Mining Work. J. T. Donald. Describes the deposits and mining at Turtle Lake, on the Canadian Pacific Railway, and gives the method used to determine the quantity of ore. 1000 w. Eng & Min Jour—July 24, 1897. No. 14236.

IRON Trade.

See same title under Economics and Industry, Commerce and Trade.

MESABA Range.

Mining Methods on the Mesaba Range. C. E. Bailey. From a paper read at the Tower meeting of the Am. Inst. of Min. Engs. Describes the deposits, systems of operating, &c. 2500 w. Ir Age—July 29, 1897. No. 14342.

MICROSCOPE Accessories.

Microscope Accessories for Metallographers. John E. Stead. Read before the Iron and Steel Inst. Hints which will facilitate work in this field. Ill. 2500 w. Engng—June 25, 1897. No. 13852 A.

PRICES.

See same title under Economics and Industry, Commerce and Trade.

PRODUCTION.

American Iron and Steel. Editorial on the annual report of the iron and steel production just issued by the American Iron and Steel Association. 1400 w. Engng—July 23, 1897. No. 14368 A.

RUSSIA.

The Russian Iron Trade. Report showing that the industry is steadily developing. 900 w. Mach, Lond—July 15, 1897. No. 14281 A.

SOUTH WALES.

See same title under Coal and Coke.

STEEL Rail.

See same title under Railroad Affairs, Maintenance of Way.

STEEL Works.

The Illinois Steel Company. Illustrated description and leading facts connected with the works of this company, with a brief historical and statistical statement. 11500 w. Ir Age—July 15, 1897. No. 14003.

TENSILE Strength.

Tensile Strength of Steel. H. K. Landis. Discusses the influences that affect the strength of steel, and presents equations, the results of a large number of tests, comments on their discrepancies, &c. 2500 w. Am Mfr & Ir Wld—July 30, 1897. No. 14382.

TESTS.

Elasticity and Fatigue. H. K. Landis. The importance of quality in construction work is noted, elasticity and fatigue defined, the usual method of testing commercial steel examined, with suggestion. 1900 w. Am Mach—July 29, 1897. No. 14319.

Univalence of Transposed Tests. N. P. Gladis. Arguing that the most satisfactory method of investigation is to submit the piece to the specific kind of stress it is designed to resist in its legitimate service. 2500 w. Ag of St—July 10, 1897. No. 13991.

MINING.

BREATHING Apparatus.

An Apparatus for Breathing in Mines. Richard Cremer. Describes the pneumatophor, an invention to enable rescuers to enter immediately, without danger, those parts of a mine full of after-damp, and to enable a miner to save himself. Ill. 1400 w. Eng & Mining Jour—July 31, 1897. No. 14391.

CONGELATION.

Sinking with Congelation, at Anzin. M. Saclier and M. Waymel. From a communication to the Société de l'Industrie Minérale. Part first gives a description of the preparatory works and the congelation. Ill. 4000 w. Col Guard—July 23, 1897. Serial. 1st part. No. 14361 A.

ECONOMY.

Economy in Mining. G. C. Mitchell. Excerpt from presidential address to the members of the Mining Institute of Scotland. The necessity of attention to details and of making the most careful preliminary calculations in connection with colliery management. 3800 w. Can Min Rev—July, 1897. No. 14380 B.

HORSES.

Selection and Management of Mine Horses. M. Ernest Boissier. From a communication to the Société de l'Industrie Minérale. Calls attention to the requirements of the work and the points necessary, that the horse may work as long and economically as possible; the care needed, food, stabling, &c. 3500 w. Col Guard—June 25, 1897. No. 13835 A.

MACHINERY.

Applications of Electricity in Mines (Les Applications de Electricité dans les Mines.) With illustrations of hoists, ventilators, pumps, locomotives, &c. 2500 w. Revue Technique—June 25, 1897. No. 14137 D.

SALE of Mines.

Legal Decisions with Reference to the Sale of Mines. It is proposed, to supply information on this subject, to notify the doctrines pronounced in England in the cases heard and determined by the high and appeal courts, irrespective of the statute law relating thereto. Various cases are presented. 3200 w. Col Guard—July 2, 1897. No. 13973 A.

SHAFTS.

Plumbing Shafts. George B. Hadesty. A republished article, giving a reliable and simple method for carrying a meridian into a mine. 1600 w. Col Eng—July, 1897. No. 14001 C.

THE NORTHWEST.

Mining in the Northwest. Arthur Lakes. An interesting general account of the advances made in mineral discoveries during the past twenty years in a region not previously recognized as a valuable mineral bearing territory. 2200 w. Col Eng—July, 1897. No. 14002 C.

U. S MINING Law.

Law of Mines in the United States. A brief review of mining legislation. 3300 w. Col

Guard—July 9, 1897. Serial. 1st part. No. 14061 A.

TUNNELS.

Tunnels and Tunnel Sites. T. A. Rickard. Discusses the value of tunnels in mining, the recent decision of the Supreme Court in the Enterprise-Rico-Aspen tunnel case, and the writer's views on this subject. 1400 w. Eng & Min Jour—July 17, 1897. No. 14041.

UNDERGROUND Photography.

Underground Photography. James Underhill. Directions showing how with simple appliances, easily carried into a rough country, valuable photographs may be secured. Ill. 1100 w. Eng & Min Jour—July 31, 1897. No. 14388.

VENTILATION.

American Fan Ventilation for Mines. Illustrations, with details of some of the large centrifugal fans. 2000 w. Ir & Coal Trds Rev—July 2, 1897. No. 13925 A.

MISCELLANY.

ALASKA.

The Alaska Trip. John Muir. An interesting illustrated description of the beautiful scenery and particulars of the journey. 6800 w. Century Mag—Aug., 1897. No. 14372 D.

ARGENTINE REPUBLIC.

Mineral Resources of the Argentine Republic. James McKean Rowbotham. An abridged paper contributed to the Inst. of Civ. Engs. Reports great variety of mineral products, and some account of the mining and value. 1500 w. Col Guard—July 16, 1897. No. 14258 A.

CALORIMETRY.

The Calorimetric Determination of Heating Values of Combustibles. (Kalorimetrische Heizwertbestimmung.) L. C. Wolff. A very full investigation of the method by chemical analysis, compared with the calorimeter tests by Mahler-Stohmann, and Kröker, with carefully worked examples. A valuable paper. 6000 w. Zeitschr d ver deutscher Ing—July 3, 1897. No. 14106 B.

CORUNDUM.

Report on Some Trial Excavations for Corundum Near Palakod, Salem District, India. Information relating to the work, the geology, proportion of corundum in the rock, cost of operations, &c. Map. 2500 w. Ind Engng—June 26, 1897. No. 14315 D.

DEFORMATION.

The Permanent Deformations of Metals. (Sur les Déformations Permanentes des Métaux.) M. Faurie. The existing formulas are re-derived by a new method of investigation, using chains with links composed of different metals. 1200 w Comptes Rendus—June 28, 1897. No. 14130 D.

FIRE Precautions.

See same title under Architecture and Building, Construction and Design.

HUNGARY.

Mines and Metallurgy in Hungary. Antoine Kerpely. Condensed translation from an article in the catalogue of the Section Hongroise, Brussels Exposition, giving information of the mining industry, working and quantity of coal. 1100 w. Col Guard—July 16, 1897. Serial. 1st part. No. 14257 A.

MINING Industry.

Mechanical and Engineering Progress as Influenced by the Mining Industry. John Birkinbine. Calls attention to some of the achievements due to the mineral resources, and their influence on the progress of the country. 3000 w. Jour Fr Inst—July, 1897. No. 13884 D.

NITROGLYCERINE.

Nobel and his work. (L'Oeuvre de Nobel.) Louis Roux. A biographical notice of Nobel with a review of the development of modern high explosives. 2500 w. Revue Technique—July 10, 1897. No. 14143 D.

ORE Deposits.

The Mine Hill Ore Deposits in New Jersey and the Wetherill Concentrating Plant. J. P. Wetherill. History of the working of the ores of Sussex County, New Jersey, with description of plant, and account of suits against the company. Ill. 3000 w. Eng & Min Jour—July 17, 1897. Serial. 1st part. No. 14040.

PETROLEUM Wells.

Petroleum Wells in the Suburbs of Los Angeles, California. Illustration with brief account of the disfiguring of a pretty suburb by the needlessly numerous and unsightly oil derricks, with some information of the yield and value. 1100 w. Sci Am—July 17, 1897. No. 14012.

PRECIOUS Stones.

Precious Stones and Recent Science. F. G. S. in *Mining World*. Notes giving some idea of the value of recent researches. 1800 w. Aust Min Stand—June 3, 1897. No. 13886 B.

TIN.

The Malay Tin Industry. T. Flower Ellis. A paper read at a recent meeting of the Chemical and Metallurgical Society of South Africa. Describes these very rich deposits, and the methods of mining and extracting the tin. Ind and East Eng—June 12, 1897. Serial. 1st part. No. 14037 D.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACCOUNTS.

Paris Gas Accounts. Report of income, expenditure, capacity, &c. 1500 w. Gas Wld—July 3, 1897. No. 13953 A.

ACETYLENE.

Illumination of Niagara Falls. Illustrated description of the lighting by acetylene gas. 700 w. W Elec—July 24, 1897. No. 14288.

Recent Research on Acetylene. G. E. Brown. Abstract of three papers by H. G. Söderbaum on his experiments with acetylene. 1100 w. Pro Age—July 15, 1897. No. 14007.

The History, Status, and Possibilities of Acetylene. Henry Harrison Suplee. Showing that greater economy of production is alone needed to make acetylene a competitor of gas. 4400 w. Eng Mag—Aug., 1897. No. 14400 A.

The Patent Side of Acetylene Gas. Information from a circular bearing on the patents owned by the Electro Gas Company of New York. 3200 w. Pro Age—July 15, 1897. No. 14008.

ANNUAL Congress.

Société Technique du Gaz en France. Abstract translations of technical papers read at this meeting. Description of the Kudlicz grate of a hinged scoop, and paper on retort-houses. Ill. 1800 w. Jour Gas Lgt—July 13, 1897. No. 14228 A.

BENZOL.

Benzol as an Illuminating Agent. (Das Benzol und seine Bedentung als Leuchtstoff.) Giving comparative results with other illuminants, both photometrically and commercially. Especially good results are obtained by usinga mixture of alcohol and benzol to heat an incandescent mantle. 2500 w. Gesundheits Ingenieur—June 30, 1897. No. 14167 B.

The Recovery of Benzol from Coke-Oven Gases. Particulars on benzol recovery obtained chiefly from a paper by Dr. C. Heinzerling. 1500 w. Jour Gas Lgt—June 29, 1897. No. 13918 A.

BURNER.

The Improved Denayrouze Burner. States the improvements as explained at meeting of the Société Technique du Gaz en France. 900 w. Jour Gas Lgt—July 6, 1897. No. 14067 A.

BY-PRODUCTS.

By-Products and Adjuncts of the Gas Industry. H. Bunte. From the proceedings of the annual meeting of the German Gas and Water Engineers at Berlin. Remarks on the mutual relation of these products from the economical and commercial point of view. 1100 w. Am Mfr & Ir Wld—July 9, 1897. No. 13980.

FURNACES.

Furnace Jottings. Maurice Graham. From *Journal of Trade Journals*, Birmingham, England. On the system of inclined retorts, and the successful working of a furnace. 2300 w. Am Gas Lgt Jour—July 26, 1897. No. 14278.

GASHOLDER.

The Middlesborough Gasholder. Mr. Henry Woodall's report upon the accident that befell the rope-guided gasholder in February last. Facts of the case with the opinion of the writer. 2200 w. Gas Wld—July 10, 1897. No. 14066 A.

JUBILEE Illuminations.

Gas at the Jubilee Illuminations. Describes some of the devices used. 2500 w. Jour Gas Lgt—June 29, 1897. No. 13919 A.

OIL Gas.

Some Notes on an English Oil Gas Process. F. Egner. Describes R. W. Herring's method as used at the Corporation Gas Works, Huddersfield, Eng. 1600 w. Am Gas Lgt Jour—July 5, 1897. No. 13840.

WATER-GAS Plant.

Carburetted Water-Gas Plant at Saltley Gas Works, Birmingham. Illustrated description of the plant and the process of manufacture. 1600 w. Engng—July 23, 1897. No. 14366 A.

SEWERAGE.

SEWAGE.

Sewage Disposal by Artificial Filtration. G. Reid. Read at meeting of Assn. of Municipal and County Engineers, England. Describes the Garfield Coal Filter and reports favorably regarding its efficiency. 2500 w. Builder—July 3, 1897. No. 13977 A.

Sewage Irrigation. Geeorge W. Rafter. Contains many details and gives a discussion of sewage purification in the United States, with descriptions of the works at various localities. Ill. 36500 w. U. S. Dept of the Interior—1897. No. 14341 D.

The Essex Fells Sewage Filter. Illustrated description of a simple and effective method of purifying a daily flow of about 20000 gallons, by distributing it over the surface of natural beds of gravel in which drains are laid to carry the inoffensive effluent into an adjacent brook. 700 w. Eng Rec—July 3, 1897. No. 13880.

The Problem of Sewage Disposal. Charles Francis. Read at the convention of the American Water Works Assn. The two systems considered worthy of discussion are the broad irrigation or sewage farming system, and intermittent downward filtration. 3700 w. Fire & Water—July 31, 1897. No. 14373.

The Sedimentation Process in Sewage Disposal. Arthur N. Talbot. Describes this method, recommending it where an inexpensive method is essential, and as a preliminary process. Discussion follows. 3500 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14206 D.

The Septic Tank System of Sewage Treatment. Donald Cameron. Portion of a paper read before the Devon and Exeter Architectural Society. Explains the system and its advantages. 1900 w. Builder—July 10, 1897. No. 14065 A.

The Sewage Filter Beds of Altoona, Pa. Information regarding the intermittent filtration adopted, and the construction of the filter beds. Ill. 2300 w. Eng News—July 22, 1897. No. 14237.

SEWER Ventilation.

Sewer Ventilation and Its Bearings upon Public Health. Edward Walford. From report submitted to Health Committee. Gives the results of investigations at different points. Thinks when sewers are well constructed and thoroughly flushed, the ventilation is a matter of minor importance. 2200 w. San Rec—July 23, 1897. Serial. 1st part. No. 14398 A.

STREETS AND PAVEMENTS.

BRICK Pavement.

A Country Road Paved with Brick. J. Ed. Miller. Describes a brick road made with crushed stone curbing. Discussion. 2000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14207 D.

Expansion of Brick Pavements in Hot Weather. Reports from Niagara Falls, Cleveland and other places regarding the upheaval of pavement, and the supposed causes. 500 w. Eng Rec—July 17, 1897. No. 14053.

How to Lay Brick Pavements. J. R. Haldeman. A brief article giving directions. 1000 w. Clay Rec—July 14, 1897. No. 14216.

Report of Committee on Paving Brick Specifications and Tests. The qualifications for durability are stated as toughness and hardness,

imperviability to liquids, and strength. Report was followed by discussion. 5000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14208 D.

STREET Cleaning.
Asphalt and Wood-Paving in Relation to Street Cleaning. Notes on the necessity of keeping asphalt clean, and the merits of these two kinds of pavement. Asphalt is considered the best of all pavements when properly cared for. 800 w. San Rec—July 16, 1897. No. 14263 A.

The Street Washing Plant at Oldenburg. (Wasserleitung zur Spülung von Srassengossen in Oldenburg.) Fr. Noack. Describing the special system of mains and hydrants for flushing and washing the streets. 2000 w. Gesundheits Ingenieur—July 15, 1897. No. 14169 B.

WATER SUPPLY.

BAVARIA.
The Water Supply of the Kingdom of Bavaria. (Die Wasserversorgung im Königreich Bayern.) An abstract from the official reports giving a general review of the work of the bureau from its establishment in 1878, to 1896. 2500 w. Gesundheits Ingenieur—June 15, 1897. No. 14164 B.

CONDUITS.
Repair Details of the Rochester, N. Y., Water-Works. Conduits in 1896. Information from report of Emil Kuichling, chief engineer, in regard to the repairs and condition of both old and new conduits. 2000 w. Eng Rec—July 24, 1897. No. 14275.

FAUCETS.
Intermittent Faucets. (Fontaine Intermittente.) The Giraud system feeds two vessels alternately from the main, and the water can only be drawn alternately by reverse operations of one lever, hence it is impossible to leave the faucet running continually. 2000 w. Revue Technique—June 25, 1897. No. 14138 D.

FILTRATION.
Water Filtration. Churchill Hungerford. An explanation of why properly constructed filter beds improve with age. Ill. 1000 w. Sci Am—July 31, 1897. No. 14294.

IRON Removal.
Removal of Iron from Ground Waters. Harry W. Clark. A report on the efforts to remove iron from the water supply of Provincetown. About 98% was removed by the use of coke. Discussion follows. 2800 w. Jour N Eng Water Works Assn—June, 1897. No. 13859 F.

The Iron-Removal Plant at Reading, Mass. Lewis M. Bancroft. Describes plant, gives Mr. Desmond FitzGerald's report and recommendations for removing the iron, also the plan adopted and the results. Ill. 1800 w. Jour N Eng Water Works Assn—June, 1897. No. 13861 F.

The Water Supply of Provincetown, Mass. Louis E. Hawes. A description of the source of supply with observations and remarks concerning the iron in the water. Also discussion. 4200 w. Jour N Eng Water Works Assn—June, 1897. No. 13860 F.

MAGDEBURG.
The Question of the Magdeburg Water Supply. (Die Wasserversorgungsfrage der Stadt Magdeburg.) Discussing the pollution of the water supply of the city of Magdeburg, and the possible methods of purification. 3500 w. Gesundheits Ingenieur—June 30, 1897. No. 14166 B.

MEASURING Evaporations.
An Apparatus for Measuring Evaporations in Freezing Weather. Describes methods used by Mr. Emil Kuichling at the Mt. Hope reservoir of Rochester, N. Y. 700 w. Eng Rec—July 31, 1897. No. 14414.

ORGANISMS.
Raphidomonas. George C. Whipple. Describes the trouble caused by a new infusorian. 3000 w. Jour N Eng Water Works Assn—June, 1897. No. 13865 F.

POTSDAM.
The Waterworks of Potsdam. (Die Entwässerung Potsdams.) With brief account of the filtering and clarifying plant. Aug. Kroitzsch. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—July 16, 1897. No. 14120 B.

PUMPING.
Pumping Machinery. Abstract of a paper by Charles A. Hague, read before the Denver meeting of the American Water Works Assn. The importance of adapting pumping machinery more closely to the work it is to do. 2000 w. Eng Rec—July 3, 1897. No. 13881.

Test of High Duty Pumping Plant Under Ordinary Working Conditions. Dabney H. Maury, Jr. Reports the test of the plant of the Peoria, Ill., Water Company, made under ordinary working conditions. Describes plant, apparatus and tests, giving results. Ill. 8000 w. An Rept of Ill Soc of Engs & Surv—1897. No. 14205 D.

RESERVOIRS.
The Failure of the Melzingah Dams of the Fishkill and Matteawan Water Co. Illustrated study of the accident. 3000 w. Eng News—July 22, 1897. No. 14243.

Two Reservoirs Burst. Illustrated description of the bursting of the Melzingah reservoirs, 500 feet up the Fishkill mountains. 600 w. Fire & Water, July 17, 1897. No. 14078.

SAND Filter.
Covered Sand Filter at Ashland, Wis. William Wheeler. A statement of the conditions, description of filter, cost, cleaning and care, operation. Followed by discussion. Ill. 10000 w. Jour N Eng Water Works Assn—June, 1897. No. 13862 F.

SANITARY Biology.
Microscopical Examination of Water, with a Description of a Simple Form of Apparatus. George C. Whipple. The importance of the study, the methods that have been employed, and description of apparatus. 2400 w. Science—July 16, 1897. No. 14027.

WATER Mains.
The Method of Laying Small Sized Water Mains; of Lowering Mains; and the Relief of Violent Fluctuations on the Direct Pressure System at Madison, Wis. John B. Heim. Paper read at convention of the Am. Water Works Assn., at Denver, Colo. Discusses the

methods employed and the results obtained. 2500 w. Fire and Water—July 24, 1897. No. 14229.

Testing Water Pipe Distribution Systems. F. L. Fuller. Describes the manner of testing pipe systems used by the writer with very satisfactory results. Discussion follows. Ill. 3000 w. Jour N Eng Water Works Assn—June, 1897. No. 13863 F.

WATERSHEDS.

A Form of Mass Diagram for Studying Yield of Watersheds. Theodore Horton. Describes a graphical solution of these problems, and the construction of the diagram. 2400 w. Eng Rec—July 31, 1897. No. 14413.

MISCELLANY.

MUNICIPAL Lighting.

See same title under Electrical Engineering, Lighting.

STABLES.

Sanitary Stables and Farm Buildings. Louis Hanks. Suggestions on drainage and other important matters. 2800 w. San Rec—July 16, 1897. No. 14264 A.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

JUNGFRAU.

The Plant of the Jungfrau Railroad. (Die Kraftaniagen, Leitunzen und Fahrzeuge der Jungfraubahn.) E. Strub. An account of the power plant and general scheme of the electrically operated rack railway now being constructed to the summit of the Jungfrau; with illustrations of the electric locomotive. 4000 w. Schweizerische Bauzeitung—July 17, 1897. No. 14149 B.

SURVEYING.

Preliminary Work in Railway Construction. (Ueber Eisenbahn-Vorarbeiten.) A paper before the German Railway Society by Dr. Jordan, of Hannover, particularly discussing the surveying and topographical work preliminary to the actual construction of road bed. 6000 w. Glaser's Annalen—July 15, 1897. No. 14159 D.

MAINTENANCE OF EQUIPMENT.

BRAKES.

Railway Safety Brakes. W. G. Creamer. An account of the circumstances that led to the invention of the Creamer safety brake, the difficulties encountered, &c. Ill. 2000 w. Ry Mag—June, 1897. No. 13934 C.

CAR Ventilation.

The Ventilation of Passenger Cars on Railroads. Charles B. Dudley. Showing the difficulties to be overcome in this problem, and a general study of the subject, with tests and experiments. Ill. 7000 w. Jour Fr Inst—July, 1897. No. 13883 D.

CAST IRON Wheels.

Specifications and Guarantee for Cast Iron Wheels. Report of committee appointed by the M. C. B. Assn. to revise the specifications and guarantee for cast iron wheels, and to consider the form of wheel. 3400 w. Ry Rev—July 3, 1897. No. 13903.

GRATES.

Locomotive Grates for Anthracite Coal. From the report of the committee of the Am. Ry. Master Mechs. Assn. Discusses water tubes, tubes with filling pieces, tubes with shaker fingers, shaking grates, and transverse shaking grates. 2800 w. R R Gaz—July 23, 1897. No. 14246.

Ratio of Grate Area, Heating Area and Cylinder Volume. From the report of the committee of the American Railway Master Mechanics' Assn. The proper ratio for freight and passenger engines. The plan followed is stated, with deductions and calculations. Diagrams. 2200 w. R R Gaz—July 9, 1897. No. 13958.

HEATING Apparatus.

Heating Apparatus, Belgian Grand Central Railway. E. Belleroche. From a paper published in the Bulletin of the International Railway Congress. Describes the system of heating passenger trains on this road, which consists essentially of circulating hot water along the train and back again, from the engine. 1500 w. Am Eng & R R Jour—Aug., 1897. No. 14323 C.

LOCOMOTIVES.

Brooks-Monon Eight-Wheel Express Locomotive. Drawings and specifications of two engines recently delivered to the Chicago, Indianapolis and Louisville Railway. 1200 w. Ry Rev—July 17, 1897. No. 14093.

Heavy Locomotives for the Southern Railway. Gives summary of the principal dimensions of 10-wheel passenger locomotives. 1400 w. R R Gaz—July 23, 1897. No. 14247.

Locomotives for the Soudan. Dimensions and details of construction of the essential parts, with illustration. 800 w. Ry Rev—July 24, 1897. No. 14287.

The Balanced Locomotive. Report of tests at Purdue University of a locomotive without driving wheel counterbalance. Ill. 3500 w. Ry Age—July 30, 1897. No. 14378.

The Latest Great Northern Single-Wheeler. Charles Rous-Marten. Describes a greatly improved engine, the departures from the usual practice being due to H. A. Ivatt, locomotive superintendent of the Great Northern Ry. Ill. 2000 w. Eng, Lond—June 25, 1897. No. 13847 A.

The Latest Heilmann Electric Locomotive. Illustrated description of the new locomotive, with brief recapitulation of the leading features of the designer's first engines, and the reasons for so radical a departure. 1700 w. Ry Wld—July, 1897. No. 14072 A.

ROLLING Stock.

Railway Rolling Stock at Berlin, Budapest, and Nürnberg, 1896. (Die Eisenbahn-Fahrbetriebsmittel zu Berlin, Budapest, und Nürnberg, 1896.) H. v. Littrow. Describing and illustrating the railway carriages at the recent expositions, giving the latest forms of continental cars—two articles, four plates. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—July 9 & 16, 1897. No. 14118 E.

VALVES.

Improved Arrangement of Reducing and Intercepting Valves—Rogers Compound Locomotives. Illustrated description of the latest form as applied to five compound locomotives now in service in Jamaica and four in Chili. 700 w. R R Gaz—July 23, 1897. No. 14244.

MAINTENANCE OF WAY.

BRIDGE Renewing.

Bridge Renewing on the C. B. & Q. Illustrated description of the method of replacing iron through truss bridges with plate girders. 1000 w. Ry Rev—July 31, 1897. No. 14417.

COLUMBIA Bridge.

Rebuilding of the Pennsylvania Railroad Bridge at Columbia, Pa. Brief historical account of the various bridges built at this point and the disasters to the structures. 700 w. Ry Rev—July 17, 1897. No. 14095.

GIRDER Bridge.

See same title under Civil Engineering, Bridges.

RAILS.

Continuous Rails. Editorial discussion of the relation existing between a rail and a continuous beam or girder, and the advantages to be derived from the adoption of continuous rails. 1800 w. Eng, Lond—July 9, 1897. No. 14059 A.

STATION Lighting.

The Lighting of Isolated Railroad Stations. Describes and illustrates a connected system of oil lighting, in use on the New York, New Haven & Hartford Railroad. 1600 w. Am Eng & R R Jour—Aug., 1897. No. 14322 C.

STEEL Rail.

The Growth and Development of the Steel Rail in America. H. G. Prout. Reviewing the history of the steel rail since 1887. Ill. 5600 w. Eng Mag—Aug., 1897. No. 14402 B.

SWING Bridge.

Railway Swing Bridge Over the River Nene. Illustrated detailed description of a bridge recently opened for traffic at Sutton Bridge, on the Midland Great Northern Railway, England. 2000 w. Eng, Lond—July 23, 1897. No. 14394 A.

TIES.

Railway Ties in India. Clement F. Street. Describes some of the designs now in use on the railways of British India, in which country metal ties have probably been more extensively used than in any other. Ill. 10500 w. Jour W Soc of Engs—June, 1897. No. 14303 D.

TILE Protection.

The Protected Railway Depot and Viaducts. Illustrated description of the improvements of the Illinois Central Railroad Company, at Van Buren and Harrison streets, in Chicago. Overhead crossing bridges, and suburban passenger station, in which fireproof tiling has been used to veneer the whole surface of the metal-work. 1800 w. Eng Rec—July 31, 1897. No. 14412.

WAY Maintenance.

Methods and Standards of Maintenance of Way. W. M. Duane. Extracts from a paper read before the St. Louis Railway Club, May 14, 1897. Discusses sub-grade, curves, ballast, rail sections, joints, &c. 1700 w. Ry Rev—July 3, 1897. No. 13904.

SIGNALING.

THOMAS System.

The Thomas Pneumatic System of Handling Railway Switches and Signals. Part first is an illustrated description of the switch arrangements of this system. 1400 w. Ry Rev—July 17, 1897. Serial. 1st part. No. 14094.

TERMINALS AND YARDS.

BOSTON Southern.

Engineering Equipment of the Boston Southern Terminal Station. An account of an unusually comprehensive and complete engineering equipment intrusted to one firm of contractors—Westinghouse, Church, Kerr & Co. 1000 w. Eng News—July 8, 1897. No. 13945.

TRANSPORTATION.

ACCIDENTS.

Railway Accidents in 1896. Review of the Board of Trade returns in England and comments on the new form in which the tables are cast. 1200 w. Engng—July 2, 1897. No. 13967 A.

Train Accidents in the United States in May, 1897. A classified statement and summary. 2000 w. R R Gaz—July 16, 1897. No. 14035.

CAR Handling.

Handling of Foreign Cars. W. E. Beecham. From the report to the Central and Western Car Service Assn. Gives recommended practice 2500 w. Ry Age—July 2, 1897. No. 13875.

EARNINGS.

Less Pronounced Railway Earnings' Increases. Report with tables of comparison, showing gross earnings for June, and for the past six months. 1800 w. Bradstreet's—June 10, 1897. No. 13944.

EXCURSIONS.

The Christian Endeavor Excursions. An account of the handling of heavy traffic on the roads west of the Mississippi, which has broken all previous records of the excursion business moving by sleeping cars. 1800 w. R R Gaz—July 9, 1897. No. 13959.

The Movement of the Excursion over the Southern Pacific. Details of how the Christian Endeavor excursion was handled. 600 w. R R Gaz—July 16, 1897. No. 14031.

FAST Runs.

Remarkably Fast Time. Report of a notable record made by the Lehigh Valley R. R. Co.'s Black Diamond express. 350 w. Col Eng—July, 1897. No. 14000 C.

GREAT BRITAIN.

Passenger Service and Rates in Great Britain. W. M. Acworth. Report of new cars and various improvements recently introduced on the different roads, with reduction in rates and changes in third-class travel. 1100 w. R R Gaz—July 16, 1897. No. 14030.

HOT Boxes.

Hot Boxes—Their Causes. M. P. Cook. From a paper presented at the May meeting of the St. Louis Railway Club. Reviews the conditions that cause hot boxes, the injury, and the writer's opinion as to the best way of cooling.

2500 w. R R Gaz—July 16, 1897. No. 14034.

INTERCHANGE.

The Rules of Interchange. Discussion of the M. C. B. Code of interchange rules at the recent convention of the Master Car Builders' Assn., with editorial. 17000 w. R R Car Jour—July, 1897. No. 13978.

OPERATING Expenses.

The Operating Expenses of Minor Railways. (Ueber Betriebs Kosten von Bahnen, Insbesondere Solcher Niederer Ordnung.) E. Rindl. A methodical investigation into the details of the operating expenses of the German tramways, and minor local roads, with formulas and diagrams. Two plates. 12000 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—June, 1897. No. 14162 D.

POOLING.

Pooling Railroad Earnings. J. A. Latcha. Claiming that the safety of the people of the United States requires the pooling of the wealth and power of the railroads under state supervision. 1500 w. N Am Rev—Aug., 1897. No. 14422 D.

RATES.

Rate Reductions in Kansas. E. P. Ripley. A protest from the president of the Santa Fé against the proposed reductions in grain rates, with editorial. 3300 w. Ry Age—July 2, 1897. No. 13874.

Rate Reductions in Kansas. W. H. Truesdale. The protest of the Rock Island road against the commission's proposed cuts. 2700 w. Ry Age—July 16, 1897. No. 14051.

TELEPHONE Dispatching.

See same title under Electrical Engineering. Telegraphy and Telephony.

TICKETS.

Interchangeable Mileage Tickets. Describes the new tickets for use of commercial travelers, with editorial comment. 2000 w. Ry Age—July 30, 1897. No. 14377.

TROPICS.

Difficulties of Transportation in the Tropics. C. P. Yeatman. Picturing the workings of competition between the locomotive and the mule. Ill. 4100 w. Eng Mag—Aug., 1897. No. 14401 B.

MISCELLANY.

ECONOMY.

Wasteful Economy. Editorial discussion as to whether the tendency toward heavier track, more powerful locomotives, and larger cars, has not reached its practical limit. 700 w. Ry Rev—July 31, 1897. No. 14418.

What Is True and False Economy in Light Railway Construction. A brief discussion of some of the requirements and of conditions that should regulate expenditure. 1000 w. Mach, Lond—July 15, 1897. No. 14282 A.

ELECTRIC Railroading.

The Status of Electric Railroading. Reviews editorially the progress in the substitution of electricity for steam, and the conditions to be met ere the advancement can satisfy those interested in railroad working. 2500 w. R R Gaz—July 9, 1897. No. 13960.

EMPLOYES.

The Physical Examination of Employés. Henry F. Hoyt. Read before the tenth annual convention of the International Association of Railway Surgeons. An argument for a physical examination of all employés, with editorial. 3000 w. Ry Age—July 9, 1897. No. 13981.

FIGHTING Snow.

Fighting Snow on the Railroads of the Northwest. Description received from E. W. Hadley, of Santa Barbara, Cal., with illustrations. 3000 w. Sci Am—July 10, 1897. No. 13906.

FLOODS.

Floods Along the Southern Railway. B. C. Milner, Jr. Illustrated account of the damage, which was much less than anticipated. 1600 w. R R Gaz—July 16, 1897. No. 14036.

HAULAGE.

Electric Haulage at Port Chalmette. G. F. P. Account of the adoption of electricity in the place of compressed air, and claiming greater economy. Also editorial objecting to conclusions and defending compressed air. 2000 w. R R Gaz—July 9, 1897. No. 13957.

INDIA.

Indian Railway Property. Reviews the conditions of these railways, and the effect of the famine. 1500 w. Engng—June 25, 1897. No. 13853 A.

Indian Railway Questions. Discusses mail service, connection with docks, conditions of recent working, the Bombay Baroda line, and the loss caused by the famine. 1800 w. Trans—June 25, 1897. No. 13873 A.

Some More Facts About Indian Railways. Information from the Administration Report on the Railways of India for the year 1896–97 prepared by the director-general of railways. Also table showing the position of all the principal railways as regards net earnings, and the percentage of net earnings to capital expenditure in the past two years. 1400 w. Trans—July 16, 1897. No. 14279 A.

JAPAN.

Railways in Japan. Report on the progress of railways, prepared by Mr. Lowther for the Foreign Office. 1800 w. Arch, Lond—July 23, 1897. No. 14371 A.

LOADING.

A Study of Load Equivalents. (Beitrag zur Lehre von den Belastungs-Aequivalenzen.) Franz Podhajsky. A graphical and analytical investigation into the manner in which the distribution of loads upon beams and girders takes place with various combinations of locomotives and cars. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—June 11, & 18, 1897. No. 14113 E.

LEGISLATION.

Railroad Legislation in Connecticut. Reviews the 16 acts passed during the present year. 800 w. R R Gaz—July 16, 1897. No. 14033.

NARROW Gauge.

Comparative Study of the Standard and the Metre Gauge. (Etude Comparative entre la Voie Normale et la Voie de 1 Metre.) J. Martin. A revival of the narrow gauge discussion, with especial reference to conditions in France. Serial. 4 parts. 18000 w. Revue Technique—May 25, June 10 & 25, July 10, 1897. No. 14141 J.

RAILROADING.

Knotty Points of Railroading. Discusses the railway conditions in the United States, and the many problems needing to be faced. Considers that both construction and competition have been overdone. 2200 w. Trans—July 23, 1897. No. 14358 A.

RAILWAYS.

Light Railways. Lists of applications granted and new schemes under consideration, with editorial comment on the effect in England of the Light Railways Act, motive power, &c. 1500 w. Ry Wld—July, 1897. No. 14075 A.

SOUTH AFRICA.

South African Railways. F. W. Wilson. An interesting account of the peculiar features of the South African railway systems, with description and matters related. 4700 w. Eng News—July 15, 1897. No. 14021.

VIBRATIONS.

See same title under Civil Engineering, Miscellany.

WATER Supply.

Water Supply for Locomotives. Thomas Appleton. From a paper read before the Western Railway Club. Discusses the quality, location of tanks, methods of supplying tanks, &c. 1200 w. R R Gaz—July 16, 1897. No. 14032.

STREET AND ELECTRIC RAILWAYS.

ACCIDENTS.

Report on the Liverpool Overhead Railway Accident. A reprint of the report of H. A. Yorke to the Railway Dept. of the Board of Trade on the accident of April 15, 1897. Gives description, evidence and conclusion. 3500 w. Elect'n—July 9, 1897. No. 14084 A.

APPARATUS.

The Thomson-Houston Magnetic Blow-Out, as Applied to Electrical Traction Apparatus. Part first considers controllers and wiring apparatus in which the magnetic blow-out is applied, showing that in the design both efficiency and wearing qualities have been studied. Ill. 1700 w. Ry Wld—July, 1897. No. 14076 A.

BERLIN.

Recent Railway Improvements in Northern Berlin. (Neuere Eisenbahnaulagen im Norden Berlins.) A very full paper by Herr Bathmann describing important underground and overhead work, with numerous illustrations and 4 plates. An important and valuable railroad paper. 15000 w. Glaser's Annalen—June 15, 1897. No. 14157 D.

BOSTON Elevated.

Estimated Cost of the Boston Elevated. Estimates of the sums necessary to go ahead with the work, as presented by George A. Kimball, engineer of the company. 700 w. R R Gaz—July 30, 1897. No. 14350.

BUENOS AYRES.

The Street Railway System of Buenos Ayres. Illustrated account of the system, which has until recently been operated by horses. Electric lines are being rapidly constructed. 1700 w. St Ry Jour—July, 1897. No. 13854 D.

ELECTRIC Railroading.

See same title under Railroad Affairs, Miscellany.

The Present Status of the Electric Railroad. F. B. H. Paine. A reply to opinions expressed in this paper, and giving the writer's views. Thinks that electricity is not yet adapted for the moving of heavy trains for long distances, but thinks there are indications of a gradual change. Also editorial. 3700 w. R R Gaz—July 30, 1897. No. 14349.

ELECTRIC Traction.

Electric Traction. Review of a book by Philip Dawson, which gives particulars of all the various systems. 2300 w. Builder—July 24, 1897. No. 14419 A.

The Deri Combined Alternating and Continuous-Current System for Electric Tramways. Description of an ingenious system, with editorial presenting its advantages and disadvantages. 3000 w. Elect'n—July 2, 1897. No. 13963 A.

FLYWHEEL Explosion.

See same title under Mechanical Engineering, Power and Transmission.

GAS Traction.

The Gas Railroad. Frederick Egner. An account of recent observations in the line of gas traction, showing that ordinary illuminating gas can be used to furnish economical means of propulsion for street railways. Ill. 1500 w. Am Gas Lgt Jour—July 12, 1897. Serial. 1st part. No. 13993.

HAULAGE.

See same title under Railroad Affairs, Miscellany.

Tramway Haulage. E. J. Silcock. Read at the annual meeting of the Incorporated Assn. of Municipal and County Engs. Part first begins the discussion of the relative merits and demerits of the various systems, briefly reviewing horse and steam traction, oil, gas and compressed air. 2400 w. Ind & Ir—July 23, 1897. Serial. 1st part. No. 14357 A.

INCLINE Railway.

Incline Railway Up Mt. Tom. Illustrated description of the road and equipment. 900 w. St Ry Rev—July 15, 1897. No. 14096 C.

INSULATION and Resistance.

Methods of Testing the Insulation and Resistance of Street Railway Lines. Frank B. Porter. Describes some of the tests usually employed by street railway electricians for determining the resistance of the insulation and the resistance of the conducting circuits of their lines. Ill. 2200 w. Elec Wld—July 17, 1897. No. 14024.

LOOP.

The Chicago Union Elevated Loop. A description, with plan, of the most complicated elevated railroad problem which has yet arisen. 2200 w. Ry Age—July 23, 1897. No. 14267.

MOTORS.

Electric Railway Motors. George T. Hanchett. Part first illustrates and describes forms of field magnets. 2000 w. St Ry Jour—July, 1897. No. 13857 D.

General Electric Company's New Street Railway Motor. Illustrated description. 900 w. Elec Rev—July 14, 1897. No. 14006.

OPERATING Expenses.

See same title under Railroad Affairs, Transportation.

POWER Plant.

Chicago City Railway Company's New Electric Power Plant. Illustrated description of interior of plant. 1400 w. W Elec—July 17, 1897. No. 14048.

POWER Transmission.

The Efficient Transmission of Power to Street Railway Lines. R. W. Conant. The subject is limited to the medium voltage, direct current transmission. The solution of a fe special cases is given, to illustrate a method used by the writer. 2500 w. St Ry Rev—July 15, 1897. No. 14097 C.

REPAIR Shops.

Some Remarks on Street Railway Repair Shop Management. Frank B. Porter. Considers a few methods which have been adopted by some systems, and found to effect a saving. 2500 w. St Ry Rev—July 15, 1897. No. 14201 C.

The Repair Shops of the Brooklyn Heights Railroad Company. Illustrated detailed description. 2700 w. St Ry Jour—July, 1897. No. 13855 D.

SPEEDS.

Investigations on the Speed of Trains on the Berlin Local Railway. (Versuche ueber die Fahrgeschwindikeit der Berliner Stadtbahnzüge) Giving the construction of the ingenious speed indicator used, with diagrams plotted by its aid. 1 plate. 4000 w. Glaser's Annalen—July 15, 1897. No. 14160 D.

STOPPAGE Losses.

Loss in Stoppages of Electric Cars. Hermann S. Herring. Reply to a query on this subject, giving the results of tests, and advising the using of brakes as little as possible and drifting as much as possible. 1500 w. Am Elect'n—July, 1897. No. 13897.

STREET Railway Bridges.

Some Street Railway Bridges. Illustrations and descriptions of some designs for street railway traffic. 1500 w. St Ry Rev—July 15, 1897. No. 14098 C.

TRACTION.

Electric Traction. M. H. Gerry, Jr. A brief discussion of some of the more important problems in the application of electric motive power to the heavier classes of railway service, with illustrations from the practice of the Metropolitan Elevated Road of Chicago. 5700 w. Trans Am Inst of Elec Engs—June & July, 1897. No. 14213 D.

TRAMWAYS.

Country Roads vs. Small Electric Tramways. (Sollen wir Land Strassen oder Elektrische Kleinbahnen Bauen?) Describing a system of very narrow gauge electric railways, with trucks upon which ordinary wagons can be carried. 1200 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14178 B.

Tramway Extension in Smaller Towns and City Suburbs. Discusses the obstacles to the extension of tramways in England. 1600 w. Ry Wld—July, 1897. No. 14073 A.

The Birmingham Tramway Report. Extract from report submitted by the sub committee on the systems of various European cities. Ill. 2500 w. St Ry Rev—July 15, 1897. No. 14200 C.

TROLLEY System.

Extension of the Underground Trolley System in New York. An outline of work undertaken on the Eighth and Fourth Avenue lines. Ill. 900 w. Sci Am—July 31, 1897. No. 14295.

Overhead Trolley System for Multiphase Motor Roads. (Oberirdische Stromzuführung für Drehstrombahnen.) An arrangement by which two overhead metallic conductors are used, giving details of double conductor trolley pole, etc. 2000 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14180 B.

The Trolley Is Free. Full text of the decision of the U. S. Circuit Court of Appeals in the case of the Thomson-Houston Electric Company vs. the Hoosick Railway Company. 4400 w. Elec—July 28, 1897. No. 14312.

WIRE.

Tension and Bending Strength of Electric Trolley Wire. (Zug-und Biegungs Festigkeit der Draht-Materialen für Elektrische Bahnen.) Giving a table of tests of various steel and copper wires. 1000 w. Deutsche Zeitschr f Elektrotechnik—June 15, 1897. No. 14181 B.

Books of the Month

Howe, Malverd A., A Treatise on Arches. Designed for the Use of Engineers and Students in Technical Schools. John Wiley and Sons, New York. Chapman & Hall, London. 1897. Cloth, $4.

An octavo volume of 371 pages, containing 73 illustrations, may seem to to the lay reader a large amount of space to devote to the almost exclusively mathematical discussion of a single element of construction. The professional reader, who readily comprehends all that is involved in the design of arches to meet special conditions of load distribution, and in the use of different materials for arch construction, will see that compactness is not necessarily sacrificed in a book of this size, and that thorough treatment of the subject is impossible within certain limits. The aim of the author appears to have been to simplify existing formulas derived from Weyruch's four fundamental equations of the elastic arch, and to present a series of general formulas which in their integral form are applicable to "any symmetrical arch, either fixed or hinged, and subjected to either vertical or horizontal loads . . . when the equation of the axis and the law of variation of the moments of inertia of the cross sections are known." The usually neglected effect of the axial stress is discussed, and formulas for all practical cases likely to occur are given. Formulas for vertical and horizontal loads, and for special cases of changes of temperature and shape, are also presented. In the treatment of the subject of masonry arches, "the many difficulties and inaccuracies of the common methods of treatment" are pointed out, and it is shown that a masonry arch may be so designed that "its stresses will follow the laws demonstrated for the elastic arch." In designing segmental masonry arches, the author adopts Alexander and Thompson's method "as being the most consistent of the many methods which assume all loading due to material to act as vertical forces upon the arch." One of the most important and valuable chapters in the book for the practising engineer is Chapter II, which contains "a collection of all the necessary formulas likely to be needed in practice," in such a simplified form that they can with the aid of tables be applied with ease and celerity. The author expresses the belief that "a fair trial of the summation formulas in this chapter will lead to the adoption of metal arches more artistic in form than the usual American type. The book is well printed, and bound in the usual style of college text-books.

Hopkins, Thomas C., M. S. M. A. Assistant Professor in the Pennsylvania State College. The Building Materials of Pennsylvania. I. Brownstones. Appendix to the Annual Report of Pennsylvania State College, for 1896. Paper.

Contains 125 pages (octavo) of text, 26 full page plates, and two maps showing location of quarries. A great deal of valuable information is presented. The author is an expert on the subject of building stones, having published several monographs on the subject in the government and different State geological survey reports and numerous shorter articles in the scientific and trade journals. Pennsylvania is one of the leading states in the production of brownstone, and is surpassed by none in the quality of the stone produced and the number of quarries. The report is divided into three parts, the first treating of the general features of brownstones, the second describing in detail the different quarries and quarry regions of the State, and the third part describing briefly the competitive quarries in other States. The first part discusses thoroughly the chemical composition of brownstones, giving a great many analyses from different quarries, and the signification of the different elements are pointed out. The structural, textural, and mineralogical features are fully described and illustrated by means of photographs and pen drawings. The durability of brownstones is discussed

at some length, and an explanation is offered for the crumbling of the brownstone in this and other eastern cities. Crushing absorption and fire tests of a great many different brownstones are given. The methods of quarrying and handling the stone, and the uses and adaptability of the different varieties are given with its distribution in the State, illustrated by a map showing the location of each quarry.

American Street Railway Investments (Red Book Supplement to the *Street Railway Journal*). New York, Chicago, and London. 1897. Cloth, $3.

In addition to the well-known special features of this publication, by which it holds a distinctive place among books of its class, are a "Review of the Year," in which is a brief exposition of the chief events bearing on street railway affairs that have occurred during the last year in the principal cities of the country, and a table of "gross receipts in 1895 and 1896" showing the percentage increase or decrease in receipts for every system whose gross receipts exceed $25,000. The information contained in this table is of much value, particularly as the companies are arranged according to magnitude of operations in 1896, so that each company can easily find out what others of its class are doing. The work also contains much information of local interest embodied in tabular form, and in the text.

The regular contents of the book include the tabular presentation of gross receipts, operating expenses, and balance sheets for from three to five years, by means of which a company's complete financial statements may be examined for surreptitious concealment of expenses or profits; the "dates of information," which are appended to each report; and the authenticity of the information, as shown by the statement that, out of 1,262 companies in existence in the United States and Canada, more than 80 per cent. have sent in "approved" reports from proof sheets sent to them before publication, while nearly all the remainder have been brought up to date from official sources of information. An unusual number of carefully-prepared and finely-engraved maps of street-railway properties is found in the "Red Book" and adds much to its value. The arrangement of indexes and their completeness is an excellent feature.

Among 1,262 corporations named, 939 are operating, 206 are operating under lease, and 117 are not yet in operation.

Wallace, Robert, F. L. S., F. C. S., F. R. S. Farming Industries of Cape Colony. P. S. King & Son, London. 1896. Cloth. 10s. 6d.

Possessing a rare educational equipment for the performance of such a task, Professor Wallace has in this treatise written one of the most interesting of contemporaneous books. To those seeking information about the climate, soil, and resources of southern Africa the work will be as valuable as it is interesting to the general reader. Eighty-one full-page plates, fourteen maps, six plans and ninety-two illustrations assist the text in the graphic representation of the peculiar features and agricultural resources of a truly remarkable country. Professor Wallace visited Cape Colony at the invitation of its government. While sojourning in the land, he was afforded ample facilities for a study of conditions under which farming must be carried on, the kinds of implements and machinery adapted to the needs of the colonial farmers, and the probable commerce which the agricultural interests of the colony have created and will create. The text embodies the results of a laborious four months' tour, in which copious notes were taken. Mr. Wallace is an acknowledged expert, being professor of agriculture in the University of Edinburgh, and it is seldom that so much of general and scientific interest is compressed in a book of this size devoted to agricultural research. The work contains 552 octavo pages, and is well indexed.

Mead, Elwood, State Engineer. Third Biennial Report of the State Engineer to the Governor of Wyoming. 1895 and 1896. The S. A. Bristol Co., Cheyenne, Wyoming. 1897. Cloth.

Mr. Mead, in this report, deals exclusively with the subject of irrigation and irrigation works, which are the most important public works in the State of Wyoming. The report is a valuable contribution to the growing literature of irriga-

tion, a subject that is constantly assuming greater importance in connection with the reclamation of the arid western lands of the United States. The report shows that a little more than one thousand water rights have been adjudicated in Wyoming since the previous biennial report was issued. Mr. Mead says that "the total volume of water thus dedicated to beneficial uses" is more than 3,394 cubic feet per second, and that water rights have, by formal certificates of appropriation, become attached to more than ninety thousand acres of land. The water is obtained for this purpose from sixty streams and two springs. The most important topics treated are "Water Rights" (pages 37 to 62) and the "Needs of Irrigation" (pages 158 to 167 inclusive). Under the latter heading are discussed the necessity for subsidies to important canals. The position is taken that, if we are to reclaim our best land and use our large rivers for this purpose, State aid in building reservoirs and large canals is imperative. The report then shows that free grants of water, and the speculative control of streams, which have formed part of the policy of other arid regions, put a perpetual mortgage on every irrigated home so supplied. There is much in this report to awaken thought, and direct public attention toward a sound policy in the reclamation of western lands, now deserts, but capable of being made exceedingly fertile and productive.

Fuertes, James H. Water and Public Health. The Relative Purity of Water from Different Sources. John Wiley & Sons, New York. Cloth, $1.50.

The principal cities of the world are herein grouped with reference to the quality of their water-supply, as a basis of a comparative study of mortality statistics. Thus the importance of pure water is placed in a stronger light than it can be by the data of more widely scattered observations. It is thought, also, that by the adoption of this method the admitted inaccuracies in the statistics presented in reports of physicians, health boards, etc., assumed as being about equally in the nature of excess and deficiency, will counterbalance each other, and the final result so attained will contain very little error. The statistics of typhoid fever in American cities have been compiled from municipal reports, reports of State boards of health, and correspondence. Four chapters precede the appendixes, which contain the compilation of data. Chapter I discusses the etiology and prophylaxis of typhoid fever; chapter II answers the question: "When does pure water pay?"; chapter III treats of the sanitary value of impounded water; and chapter IV summarizes conclusions derived from the data compiled. Appendix A gives statistics of death-rates from typhoid fever per 100,000 of population in various cities for the years 1890–1895 inclusive. Appendix B contains descriptions of the sources of water-supply of various cities. Appendix C gives the annual rain-fall as observed at some fifty cities of the United States. Appendix D contains a table showing the number of times that different typhoid-fever death-rates per 100,000 occurred in all the cities named in appendix A, during the six consecutive years beginning with 1890. Diagrammatical representations of death-rates are also presented. The book supplies in a very convenient form for comparison and reference a mass of data not otherwise obtainable without an expenditure of time which most engineers would gladly avoid.

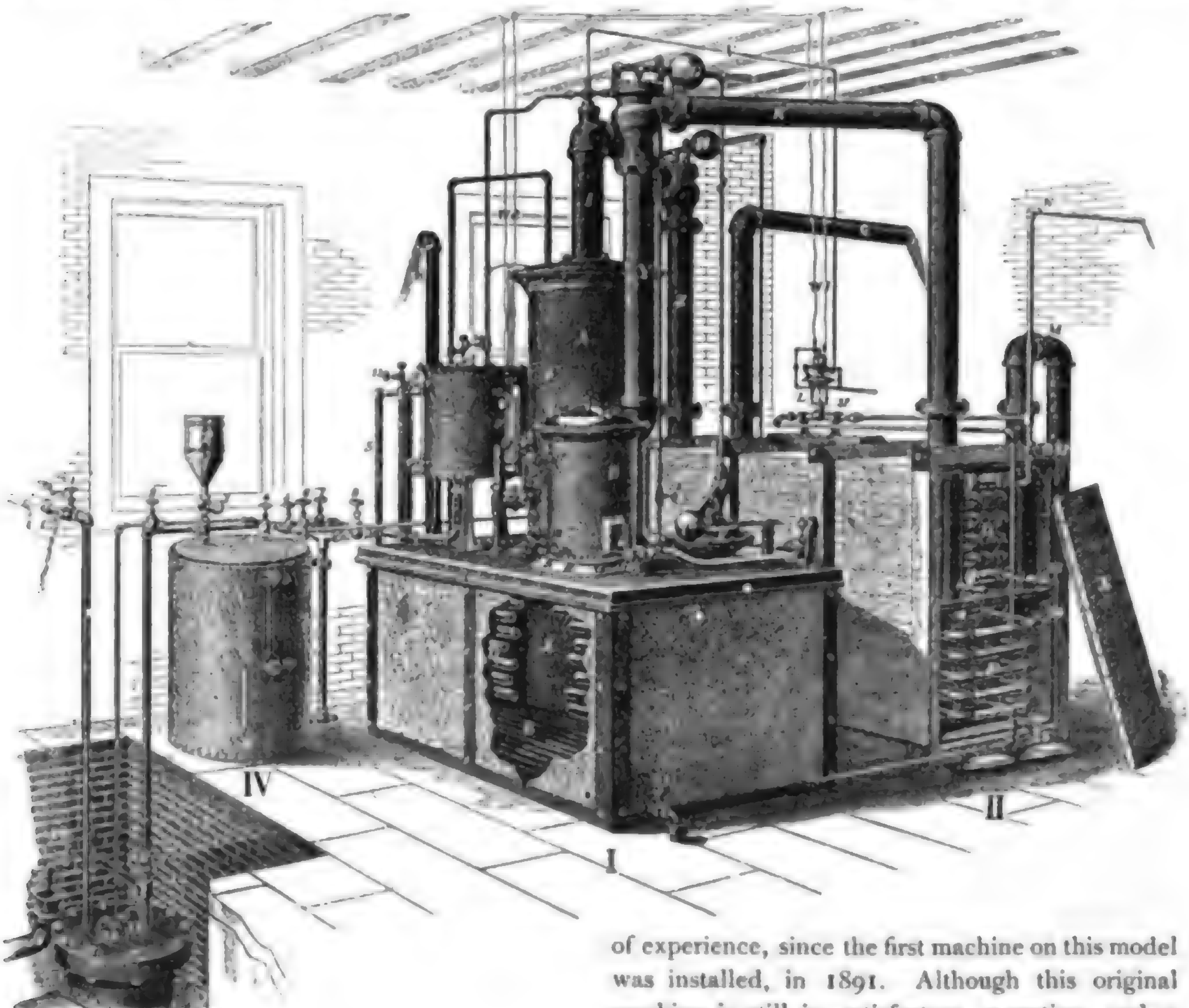
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The "New" American Oil Gas Machine.

THIS machine is designed for the generation of a pure hydrocarbon gas from naphtha, for use as fuel. The system is based upon the belief that it no longer accords with scientific progress to use coal in a crude state, and that every consideration of economy requires the separation of crude fuel into its component parts before the performance of its final function. It is the object of the system to convert the total of a given amount of refined petroleum into gas, which is then converted into heat without waste by draft or consumption in unused space. There is produced a practically fixed gas consisting of dry air charged with atomized oil. No gas-holder is required, but gas is discharged directly into the main pipe under a constantly even pressure.



The system is not new, properly speaking, but attention is called to what the manufacturers designate as the "New" American Oil Gas Machine, illustrated in an accompanying engraving. It embodies every improvement suggested by six years of experience, since the first machine on this model was installed, in 1891. Although this original machine is still in satisfactory operation, and a considerable number have gone into use in each year since, with the approbation of the purchasers, the manufacturers are now able to offer for the first time what they themselves can approve of as a complete piece of work in this line.

The gas machine proper (Fig I) contains the generator, A; the feeding tank, B, which regulates the supply of oil to the generator; the water pressure regulator, C; the circulating pipe, D, an

elongated coil through which the oil flows to be warmed after passing through the generator unconverted; the radiator, E, for raising the temperature of the oil circulating in the machine.

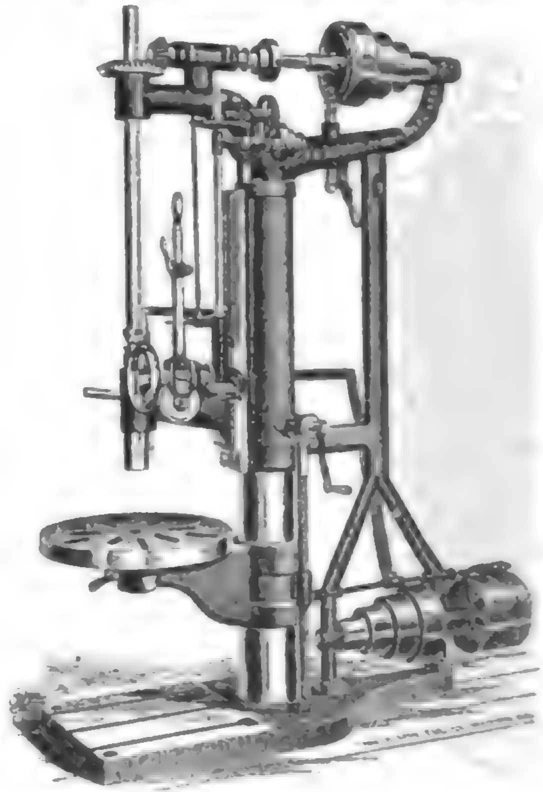
Fig. II. shows the heating chest provided with steam for heating the air supply before it enters the generator, and the gas after it leaves the generator. It has two compartments: P, for air as it comes through the blower, and O, the chamber for heating the gas, received by the pipe Y and discharged to the storage tank by the pipe M. Fig. III is the storage tank for oil. It shows the head of a reservoir of 8,000 gallons capacity, four feet under ground, project ng into the gas house under an arch or beam. All connections pass through a thick manhole cover. Figure IV is the measuring tank used to ascertain the consumption of oil, by reference to gage glasses.

This machine forms part of a patented system embracing (1) a fuel gas generator; (2) a blower for the regulation of pressure in the generator and at the points of consumption; and (3) the furnace in which the heat of the gaseous fuel is utilized. The system is used by leading manufacturers of bicycle material, watches and machinery, and by assayers and refiners of bullion, and others who desire an efficient, perfectly controllable, and economical system of generating and utilizing fuel gas.

The manufacturers, The American Gas Furnaces Co., 23 John St., New York, not only use the gas produced by this system in their furnaces, but also in the production of power in their works, at Elizabeth, N. J., and also for lighting the factory. They are prepared to supply inquirers with information as to the comparative cost of their gas and other forms of fuel, and also as to its merits in other respects.

New Sliding Head Back-Geared Drill.

THIS drill has been designed and placed on the market by the W. F. & John Barnes Company, Rockford, Ill., U. S. A., in response to an inquiry for a smaller drill than the 28-inch drill manufactured by the same company, and also to meet all the requirements for a drill intermediate in size and capacity between their 25-inch stationary head drill and their 28-inch and 34-inch sliding head drills. The new machine—illustrated herewith—has been designed with special care, and is believed to embody all features essential to a complete and perfect tool. The workmanship is first-class. The feed arrangement is especially strong, and provides for all the different feeds which can be used on a drill press. The cut shows very clearly the feed mechanism. The drill has power self-feed with automatic stop, lever and worm feed, and quick return for spindle. The feature of hand lever feed on a sliding head drill in combination with worm and power feed is new and increases the usefulness of the drill. Every movement of the drill is designed for the convenience of the operator, who has at his disposal five



different feeds; a lever feed, hand worm feed, self power feed, automatic stop, and quick return. The back-gear is claimed to be the neatest and cleanest back-gear on the market; it is of internal movement and free from dirt, and gives the best of satisfaction.

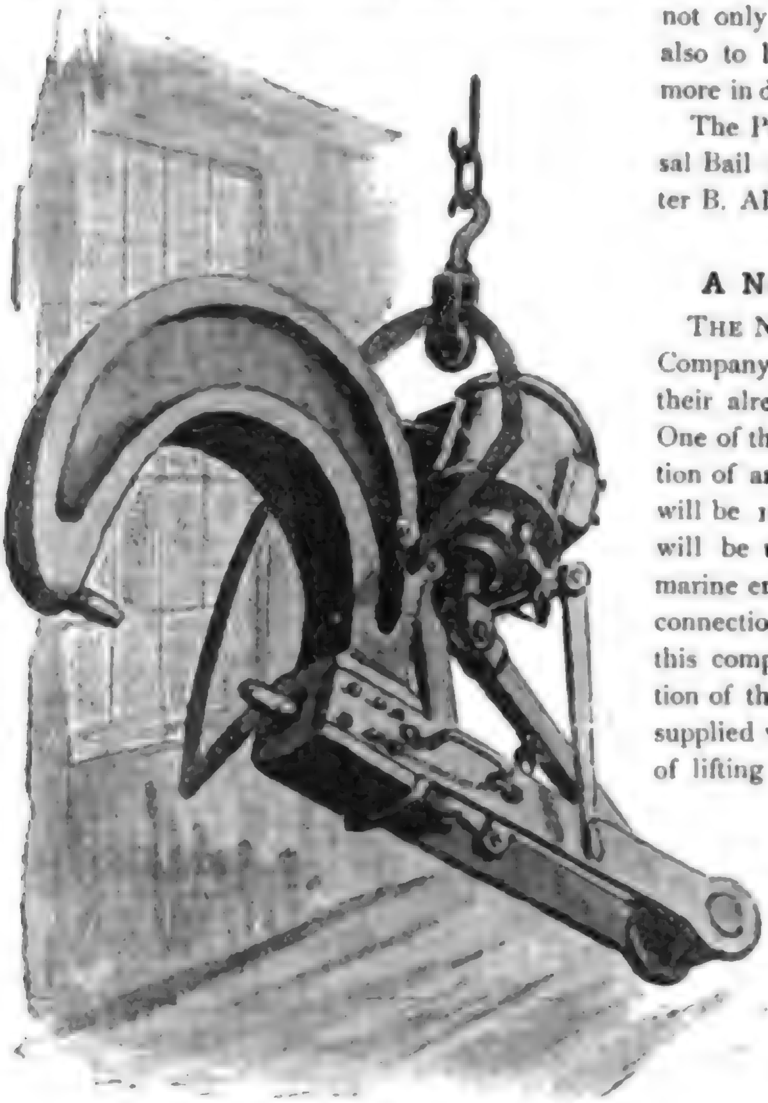
The spindle is fitted with the No. 3 Morse taper.

The Pittsburg Riveter and the Albree Universal Bail.

THE development of pneumatic machinery, during the last ten years is one of the most marked features of mechanical advancement. The invention of special machinery, to accomplish work hitherto done by hand or by more cumbersome machines, is keeping pace with invention in other new fields. Among the latest adaptations of compressed air power, is the Pittsburg Riveting machine.

It consists of a simple trunk piston cylinder—which exerts its force on a revolving lever carrying a hardened steel roller on its lower end, the upper end having a fixed center. The roller travels on the upper surface of a h rdened steel roller bar—fixed at one end and attached to a plunger—

moving in guides at the other end. In this plunger is a screw, carrying a riveting die, which, by the movement of the roller on the roller bar, is caused to move vertically. The power is increased



by leverage of the toggle-joint type, so that at the end of the stroke the pressure is practically immeasurable. The cut illustrates the latest type of this riveting machine. This latest form has a new and tested device, shown clearly in the cut, which adapts the machine to a variety of work that was not possible heretofore, except by means of cumbersome worm geared appliances.

The device consists of a semi circular bail—pivotted on trunnions, whose axis passes through the absolute center of gravity of the machine. The trunnion is suspended from a grooved roller, held in a swivelled fork. Being suspended from its center of gravity, the machine is held in perfect equilibrium. It follows that, in whatever position the riveter is turned, the grooved roller will always be over the true center of gravity, and that the machine can be held in any position in any plane, and yet perform its work as well as if it were in the ordinary vertical position.

The engraving shows the machine in a very peculiar position, and those using such machines can readily understand how useful this attachment would be for riveting crooked work, field work, circular pieces, etc. The Universal Bail is applied not only to small machines, such as shown, but also to large machines with throats five feet or more in depth.

The Pittsburg Riveter and the Albree Universal Bail are patented and manufactered by Chester B. Albree, Allegheny, Pa.

A Notable Contract for Steelwork.

THE Newport News Shipbuilding & Dry Dock Company are making extensive additions to their already large plant at Newport News, Va. One of the large additions under way is the erection of an extension to their machine shop, which will be 100' wide and 200' long. This building will be used for the finishing and erecting of marine engines and other large machinery used in connection with the mammoth steel vessels which this company has under way. The central portion of the building will be 50' high, and will be supplied with an electric travelling crane capable of lifting and carrying a load of 50 tons. On either side of this central space will be located a gallery arranged for small machines and fitting tools. The building is to have a steel framework throughout, and the roof is to be covered with corrugated iron. The Berlin Iron Bridge Company, of East Berlin, Conn., have the contract for furnishing and erecting the steelwork of the building.

NEW CATALOGUES.

Archer Iron Works, Chicago, Ill., U. S. A.= A neatly illustrated folder showing the different forms of steel wheel-barrows manufactured by this company. Steel barrows for handling all kinds of material are included.

Michigan College of Mines, Houghton, Mich.= Preliminary announcement for 1897-1898.

General Electric Company, Schenectady, N. Y., U. S. A.=Fifth annual report, 1897.

The Dayton Globe Iron Works, Dayton, Ohio, U. S. A.=(*a*) Elegantly printed, illustrated pamphlet, describing the "New American turbine with tables of hydraulic data, and details of wheels and setting, flumes, etc., etc (*b*) Pamphlet setting forth advantages, points of superiority, etc., of the "New American" turbine.

Garvin Machine Company, New York.= Pamphlet containing beautiful half-tone interior of the company's new building and its fine and complete equipment.

American Institute.=Press Bulletin American Institute Fair to be held Sept. 20, to Nov. 4th, at Madison Square Garden, N. Y. Allen S. Williams, Madison Square Garden, New York City, Chief of Press Bureau.

Boston Belting Company, Boston, New York, and Buffalo, U. S. A.=Card, describing advantages of Phoenix flange and joint packing.

Joseph Dixon Crucible Company, Jersey City, N. J., U. S. A.=Pamphlet, entitled "The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared."

R. D. Wood & Co., Philadelphia, Pa.=Elegantly printed and illustrated catalogue of hydraulic tools, cranes, and machinery.

The Link-Belt Engineering Company, Nicetown, Philadelphia, Pa.=Pamphlet entitled "Modern Methods," photographically reduced from large standard pamphlet size to small pocket size. Contains full, illustrated description of the link-belt system and its details.

James Leffel & Company, Springfield, Ohio, U. S. A.=New illustrated pamphlet describing horizontal and vertical throttling and automatic engines and portable and stationary boilers manufactured by this company.

New Jersey Car Spring & Rubber Company, Jersey City, N. J., U. S. A.=Illustrated descriptive catalogue of vulcanized rubber goods, including belting, packing, tubing, gaskets, valves, hose, etc., etc.

The Westinghouse Machine Company, Pittsburg, Pa.=Illustrated descriptive catalogue of Westinghouse gas-engines, setting forth their applications and advantages.

Lehigh University.=In view of misleading reports about the future of this institution which have been admitted to the columns of the daily press, the students, alumni, and friends of Lehigh University have united in a denial that it is in such a crippled condition as has been industriously represented. The partial failure of the ordinary revenues of the University has been followed by a liberal grant from the State, which will enable the college work to proceed without interruption. There is such a sentiment in favor of upholding this institution, manifested in the representative daily papers of Philadelphia and other large towns in Pennsylvania and throughout the State, and the action of the legislature in granting relief has been so generally approved, as to give assurance of a permanent future to this once promising seat of learning.

Harrison Safety Boiler Works, Philadelphia, Pa., U. S. A.=Illustrated pamphlet entitled "Additional Evidence of the Merits and Value of the Cochrane Separators." Describes the Cochrane separator and its operation, and gives a list of about a thousand users of this separator. A few pages are devoted to the Cochrane feed-water heater.

Toledo Machine Tool Company, Toledo, Ohio, U. S. A.=Catalogue and price-list for 1897, illustrating and describing a line of punching presses, drop presses, dies, and special machinery for working bar and sheet metals.

Clayton Air Compressor Works, New York.=Catalogue No. 9. Claimed to be the most complete catalogue of air compressors and compressed-air appliances ever attempted. It contains not only a description of the Clayton type of air compressors, with illustrations and lists of sizes and standard patterns, but also a descriptive article entitled "The Widening Use of Compressed Air," an explanation of the Clayton air-lift pumping system, and data for figuring the loss of pressure due to friction in transmitting compressed air through pipes, and in operating compressors at different altitudes above the sea.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.="A," '97 Pocket edition catalogue of four hundred pages, being the pocket edition of the library bound book published in December last. A large edition of this very neat and compact publication has been printed, principally for engineers, and will be sent gratuitously upon application. As much matter is compressed into this little book, by the use of very small, but very clear, type, as is often contained in large octavo. It is unique among trade publications.

Cincinnati Corrugating Company, Piqua, Ohio. U. S. A.=Catalogue for 1897, illustrating and describing corrugated and galvanized building materials manufactured by this company, which claims to have been the first corrugating company in America.

The Westinghouse Air Brake Company, Pittsburg, Pa., U. S. A.=Pamphlet entitled "The Westinghouse High-Speed Brake." Illustrating and describing a distinct advance in the air-brake art.

Boston Motor Company, Boston, Mass.=Catalogue of experimental electrical supplies.

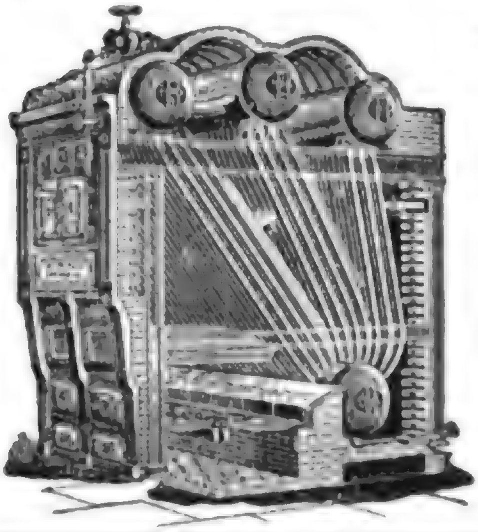
Randolph & Clowes, Waterbury, Conn., U. S. A.= Pamphlet, entitled "Touching a Tubular Triumph; The Due Reward of Nineteen Years of Seamless Tube Drawing.=Sets forth progress in the art, and illustrates and describes the achievements in copper tube drawing accomplished at their works, with an illustrated description of the special tube drawing machine employed by this firm in the manufacture of large-sized seamless drawn copper tubes.

Newburgh Ice Machine & Engine Company, Newburgh, N. Y., U. S. A.=Illustrated descriptive catalogue of ammonia ice machines, Whitehill-Corliss engines, etc., etc.

W. A. Hartt, Los Angeles, Cal., U. S. A.= Pamphlet, illustrating and describing Hartt's gravity elevator and tramway combined.

The Wais & Roos Punch and Shear Company, Cincinnati, Ohio, U. S. A.=Catalogue illustrating and describing a line of punches and shears, with price lists.

Dodge Manufacturing Company Mishawaka, Indiana, U. S. A.=*a*) Large handsome catalogue of power transmissions appliances, including wood split pulleys, appliances for rope transmission, etc., and a copy of the decision of Judge Sage sustaining the Dodge and Philion patent, No. 200,402. (*b*) Chronological statement of actions, injunctions, etc.,—Dodge and Philion patent No. 200,462. (*d*) Circulars relating to the recent decision of Judge Sage, and the litigation which it terminated.



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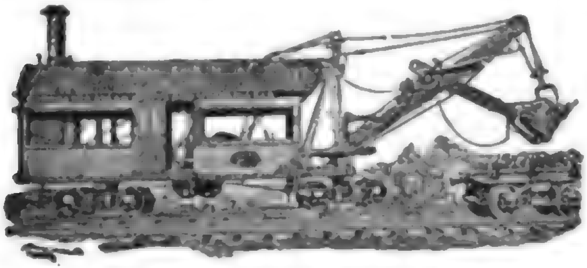

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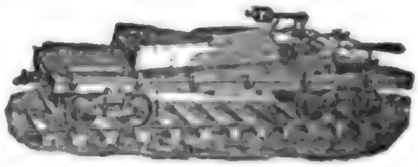

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AUTHORS AND PAPERS FOR SEPTEMBER.

J. STEPHEN JEANS (*Lessons of the Great Engineering Strike in England*)=For many years secretary of the British Iron Trade Association, and editor of the *Engineering Review* (London); was for a long time secretary of the British Iron and Steel Institute, and in that capacity visited the United States in 1890. He visited the Chicago exhibition in June, 1893, as the special commissioner of the British Iron Trade Association, and afterwards read a paper before that body on "The Chicago Exhibition, and its Lessons to the British Iron Industry." He is the author of numerous scientific and economic works and pamphlets, a contributor to the principal English magazines, and a fellow of several learned Societies in Great Britain. At present is editor and chief owner of *The Iron and Coal Trades Review*, London.

HENRY HARRISON SUPLEE (*Strength and Failure of Masonry Arches*)=Born October 23, 1856, at Philadelphia, Pa; graduated from the University of Pennsylvania in 1876, in the department of mechanical engineering; acquired practical experience in the mechanical establishment of his father the late Nathan R. Suplee; draftsman and designer for the firm of London, Berry & Orton, woodworking machinery, of Philadelphia, for a number of years; 1887 to 1890 editor of *Mechanics*; afterwards for five years with the Yale & Towne Mfg. Co., of Stamford, Conn.; at present consulting engineer and scientific expert in Philadelphia. Mr. Suplee has translated and published Reuleaux's "Constructor," and has also been a frequent contributor to the technical press. He is an active member of the American Society of Mechanical Engineers, and of the Franklin Institute, and has an extensive technical acquaintance and correspondence with foreign scientific men.

HORACE V. WINCHELL (*Soft Ore Mining by the Methods of the Minnesota Iron Company*)=Born in Michigan in 1865; graduated at the University of Michigan in 1889; Assistant State Geologist Minnesota, 1889–1891; in charge of explorations for Minnesota Iron Company, 1892–93; since 1893 has been engaged in practice of his profession as economic geologist and mining expert—office and laboratory at Minneapolis, Minn.; during past two years chiefly engaged in gold mining regions of the West; author of numerous brochures on ore deposits; joint author with Prof. N. H. Winchell of "The Iron Ores of Minnesota"; Fellow Am. Assoc. Adv. Sci; Fellow Geol. Soc. Am.; Member Am. Inst. Min. Eng., N. of Engl. Inst. Min. and Mech. Eng., Inter. Cong. Geol., etc.; corresponding editor for *Zeitschrift für praktische Geologie*, of Berlin.

PERCIVAL ROBERT MOSES (*Isolated Plants versus Central Stations*)=Born in New York; educated abroad and in U. S.; entered School of Mines, Columbia College, 1891; graduated in 1895–1896, with degree of electrical engineer; with Sprague Elevator Company in factory and construction work, 1896 to date; consulting engineer; associate member of the American Institute of Electrical Engineers.

LIEUTENANT RIDGELY HUNT, U. S. N. (*Fifty Years' Advance in Marine Engineering*)=Graduated from Annapolis in 1875; his father was Judge Hunt, Secy. of the Navy under Pres. Garfield and afterwards Minister to Russia; Lieut. Hunt's last shore duty was in the Office of Naval Intelligence, where he contributed to the Annual issued by that department; on his last cruise, Lieut. Hunt was secretary and aid to Admiral Gherardi during the naval review of 1893; he is now stationed at the Hydrographic Office, Maritime Exchange, this city.

AUTHORS AND PAPERS FOR SEPTEMBER.

J. PARKE CHANNING (*Mine Accounts*)=Born in New York City 1863; graduated at Columbia School of Mines in 1883; soon after went to Houghton, Michigan, with S. E. Cleaves & Son, manufacturers of mining machinery; afterward with the Tamarack, and Osceola mines as assistant mining engineer; was appointed deputy commissioner of mineral statistics, and wrote that part of the State report for 1884 covering the copper mines; spent a year in Honduras for Michigan capitalists, establishing steamboat navigation on the Ulua River and examining places and mineral lands; returned to Michigan in practice of general engineering, and in 1887 was appointed Inspector of Mines for Gogebic Co., holding that place till 1890; was superintendent of the East New York Iron Mine, and later in charge of the development company in Michigan of the Chicago, Milwaukee and St. Paul Ry.; resigned to accept a position with the Calumet and Hecla Mining Co., as assistant manager; since 1894 has been located at 34 Park place, New York City, as consulting engineer. It was at his suggestion, in 1885, that the Michigan Mining School was established. His proposal led to the founding of the Lake Superior Mining Institute, of which he was president in 1895. He has been an occasional contributor to the technical press.

E. T. ADAMS (*Economical Power Production in Small Units* =Received a varied technical training, working his way up from the workman's bench; early training in public schools at Hyde Park, Ill.; after a number of years work, chiefly in mechanical lines, received a university education at Stanford and at Cornell; his experience as stationary engineer entitles him to speak with authority on the status of this occupation; was instructor in charge of the department of drawing in city schools of Stockton, Cal.; instructor in mechanical drawing and descriptive geometry at Stanford University; graduate Cornell Unive sity, M. E, 1894; employed as designer by a prominent firm of engine builders; and at present instructor in department of machine design, Cornell University. Has contributed more or less to technical and other papers for several years past.

HAROLD B. GOODRICH (*The Gold Fields of Klondike and the Yukon Valley*)=Born in Hartford, Conn., in 1870; graduated A. B., Harvard, 1892; was employed as Assistant Geologist on the U. S. Geological Survey from 1894 to July, 1897; visited the Yukon River Gold Fields in Summer of 1896 as one of the members of the U. S. Geological Survey party.

W. WORBY BEAUMONT (*The Present Status of the Horseless Carriage Industry*)=Born 1848; apprenticed 1864 to the Reading Iron Works Co., steam engine, machine and agricultural implement makers, where he was engaged in construction of Lenoir gas-engines; he had previously for several years spent all the time school-hours would permit in small foundry and machine works belonging to his father; in 1867, went as improver to Ransomes, Sims & Jefferies, Ipswich, under his grandfather William Worby, (inventor of first portable steam thrasher, the self-moving steam-plough anchor, etc.), where he was engaged in erecting steam-engines and machinery; in 1872, became assistant and afterwards chief assistant to late Robert Mallet, F.R.S., civil engineer engaged on mechanical-engineering branches of civil-engineering work; subsequently was engaged in varied civil and mechanical-engineering and expert work, and afterwards was for over ten years joint editor of *The Engineer*, a position which he resigned early in 1896 in consequence of growth of his private practice in mechanical and engineering work, which he had carried on several years; has devoted much time to oil and gas-engine construction and testing, and latterly turned his attention to mechanically-propelled vehicles, in which his early experience with traction engines has been of value; is the inventor of the Vibromotor, now extensively used in all kinds of screening machinery, the antinertia variable-speed gear, tea machinery, and steam generators. His varied experience causes his frequent occupation as expert in patent and engineering litigation; is a member and gold medallist of the Institution of Civil Engineers, member of the Institution of Mechanical Engineers, Fellow of the Geological Society, and numerous other societies, and author of numerous papers in their proceedings.

FREDERICK HART SHELTON (*The Extending Use of Gas in Mechanical Operations*)=Born in Derby, Conn.; leaving College, Towne Scientific School, University of Penn., at the end of Freshman year, took up the profession of gas engineer; for twelve years in the service of the United Gas Improvement Company, actively occupied in the designing, construction and operation of various gas plants; has also been particularly identified with the development of the Lowe water gas process, which is now used for the manufacture of the greater portion of the illuminating gas made in the United States; in 1896 assumed the management of the Welsbach Light Company's interest in Chicago and the west; at present occupied in the field of incandescent gas lighting, at 67 Washington Street, Chicago; has published "Water Gas in the United States, Past and Present," "A Consideration of the Arguments For and Against Water Gas," "Gas Engines in the United States," and other articles in gas trade journals, and papers read before the American Gas Light Association, the Western Gas Association, the New England Association of Gas Engineers, and the Ohio Gas Light Association, of each of which he is a member.

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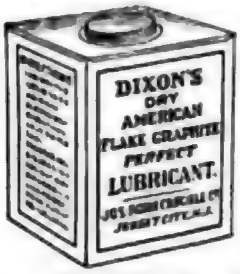

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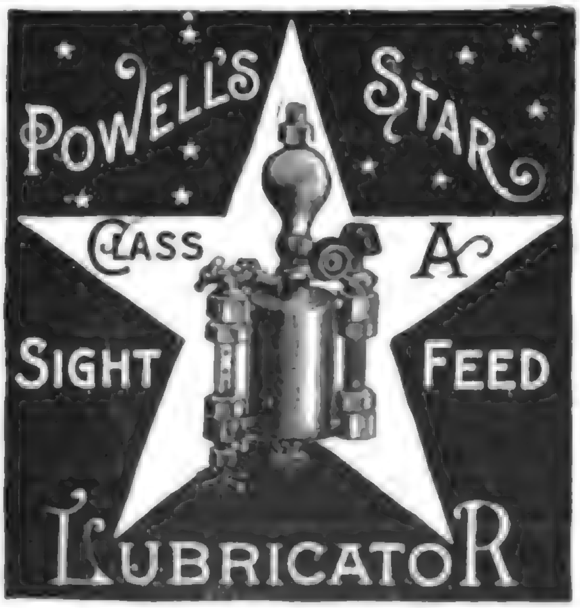

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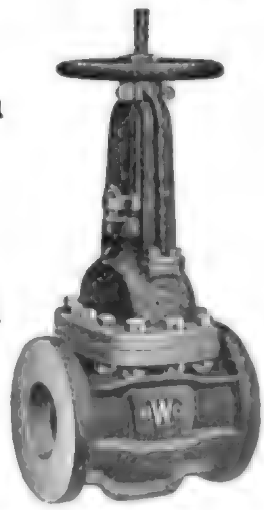

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Put up in collapsible tubes, 1½-ounce, 15 cents; 3-ounce, 25 cents; 1-pound can, 75 cents.
Forwarded prepaid on receipt of price.

THE MARLIN FIRE ARMS CO.
New Haven, Conn.

The BEST for all metals. For sale in *Bulk.*

SUPERIOR Graphite Paint

For BRIDGES, ROOFS, STRUCTURAL IRON, and all Exposed Metal or Wood Surfaces.

Warranted not affected by heat, cold, salt brine, acid fumes, smoke or chemicals.

Detroit Graphite Mfg. Co., DETROIT, MICH.

A Buyers Directory

of

The Engineering Trades.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index on page 21.*

Acid Works Castings.

Phosphor-Bronze Smelting Co., Lt., Phila., Pa.

Advertising Experts.

Manufacturers' Advertising Bureau, 126 Liberty St., New York.

Air and Gas Compressors.

Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Wks, 26 Cortlandt St., N.Y.
Filer & Stowell Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Aluminum.

Pittsburg Reduction Co., Pittsburg, Pa.

Anti Friction Metals.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Architectural Iron.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Passaic Rolling Mill Co., Paterson, N. J.
Winslow Bros. Co., Chicago, Ill.

Architectural Sheet Metal Work.

Cincinnati Corrugating Co., Piqua, Ohio.
Merchant & Co., Inc., Philadelphia, Pa.
W. H. Mullins, Salem, Ohio.

Ballast Unloaders.

Marion Steam Shovel Co., Marion, Ohio.

Batteries, Electric.

Electric Storage Battery Co., Philadelphia, Pa.

Belt Cement.

Shultz Belting Co., St. Louis, Mo.

Belt Dressing.

Jos. Dixon Crucible Co., Jersey City, N. J.
Shultz Belting Co., St. Louis, Mo.

Belting.

Boston Belting Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Main Belting Co., Philadelphia, Pa.
New York Belting & Packing Co., Ltd., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Bending Rolls.

Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.

Blast Furnaces, Gas.

American Gas Furnace Co., Elizabeth, N. J.

Blowers.

American Blower Co., Detroit, Mich.
American Gas Furnace Co., Elizabeth, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Gates Iron Works, Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Boats, Sheet Steel.

W. H. Mullins, Salem, Ohio.

Boilers.

Abendroth & Root Mfg. Co., 28 Cliff St., New York.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Edw. P. Allis Co., Milwaukee, Wis.
Cahall Sales Department, Pittsburg, Pa.
Chandler & Taylor Co., Indianapolis, Ind.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.
The Hazelton Boiler Co., 716 E. 13th St., New York.
Heine Safety Boiler Co., St. Louis, Mo.
Pittsburg Locomotive Works, Pittsburg, Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

Boiler Fronts and Fittings.

Reliance Gauge Co., Cleveland, Ohio.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Bolt Cutters.

Acme Machinery Co., Cleveland, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

For Alphabetical Index to Advertisers, see page 21.

Bolt and Rivet Headers.

Acme Machinery Co., Cleveland, Ohio.

Books.

Wm. T. Comstock, 23 Warren St. New York.
The Engineering Magazine, 120-122 Liberty St., N. Y.
Laborer's Instruction Publishing Co., St. Louis, Mo.
Ward & Gow, Union Sq., New York.

Boring Machines.

E. W. Bliss Co., Brooklyn, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Box Makers' Machinery.

J. A. Fay & Co., Cincinnati, Ohio.
The Egan Co., Cincinnati, Ohio.

Bricks.

Henry Maurer & Son, 420 E. 23d St., N. Y.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.

Bridge Builders.

Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Bridge Railing.

Chester B Albree, Allegheny, Penna.

Builders' Elevators.

John F. Byers Machine Co., Ravenna, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Building Materials.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co., Cleveland, Ohio.
Cincinnati Corrugating Co., Piqua, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Henry Maurer & Son, 420 E. 23d St., N. Y.
H. W. Johns Mfg. Co., New York.
Joseph Dixon Crucible Co., Jersey City, N. J.
Merchant & Co., Inc., Philadelphia, Pa.
W. H. Mullins, Salem, Ohio.
Pancoast Ventilator Co., Inc., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
N. & G. Taylor Co., Philadelphia, Pa.
Winslow Bros. Co., Chicago, Ill.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Robt. Wetherill & Co., Chester, Pa.

Cables, Electric and Submarine.

The Okonite Co., Ltd., 253 Broadway, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
H. Channon Company, Chicago, Ill.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.

Card Index Files.

Globe Company, Cincinnati, Ohio.

Car Shop Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Filer & Stowell Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Cement.

Atlas Cement Co., 143 Liberty St., New York.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Philadelphia, Pa.

Chemical Works Machinery.

Atlantic Works, East Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Clutches, Friction.

Robert Poole & Son Co., Baltimore, Md.

Coal and Ashes Handling Machinery.

C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., . olumbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Coal Mining Machinery.

Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
General Electric Co., 44 Broad St., New York.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.

For Alphabetical Index to Advertisers, see page 21.

Sullivan Machinery Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Washing Machinery.

Cuninghame & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Cold Saws.

Q. & C. Co., Chicago, Ill.

Compressed-Air Shop Tools.

Clayton Air Compressor W'ks, 26 Cortland St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortland St., N. Y.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.

Condensers.

Edw. P. Allis Co., Milwaukee, Wis.
Deane Steam Pump Co., Holyoke, Mass.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.

Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Bryan & Humphrey, St. Louis, Mo.
Blood & Hale, Boston, Mass.
A. B. Bowers, San Francisco, Cal.
Century Engineering Co., Cleveland, Ohio.
C. M. Conradson, Madison, Wis.
M. Fargusson, Southport, N. C.
R. B. Hussey, Seattle, Wash.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, St. Louis, Mo.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
H. B. Roelker, 41 Maiden Lane, New York.
Sargent & Lundy, Chicago, Ill.
Wm. O. Webber, Boston, Mass.

Contractors.

A. B. Bowers, San Francisco, Cal.
Century Engineering Co., Cleveland, Ohio.
D. Cuozzo, 150 Nassau St., New York.
Julian Kennedy, Pittsburg, Pa.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.

Contractors' Supplies.

John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Chicago Flexible Shaft Co., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Lambert Hoisting Engine Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Conveying Machinery.

W. J. Clark & Co., Salem, Ohio.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.
Orford Copper Co., 37 Wall St., New York.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Inc., Philadelphia, Pa.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Willis Shaw, Chicago, Ill.

Diamond Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 100 Broadway, N. Y.

Dies and Die Forgings.

E. W. Bliss Co., Brooklyn, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Digesters.

Atlantic Works, East Boston, Mass.

Drawing Instruments and Materials.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
The Montgomery Company, 105 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.

Dredging Machines.

A. B. Bowers, San Francisco, Cal.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

For Alphabetical Index to Advertisers, see page 21.

Drilling Machines.

W. F. & John Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Hammers.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Fladd Press Co., Watertown, N. Y.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.

Dynamos.

American Engine Co., Bound Brook, N. J.
H. B. Coho & Co., 203 Broadway, New York.
General Electric Co., 44 Broad St., New York.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Machinery and Supplies.

American Engine Co., Bound Brook, N. J.
Bristol Co., Waterbury, Conn.
H. B. Coho & Co., 203 Broadway, New York.
Electric Storage Battery Co., Philadelphia, Pa.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Queen & Co., Inc., Philadelphia, Pa.
Wm. R. Quimby, 59 Liberty St., New York.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H K. Porter & Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators.

Gates Iron Works, Chicago, Ill.
Morse, Williams & Co., Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Emery Wheels.

The Montgomery Company, 105 Fulton St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Chicago Flexible Shaft Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Engines, Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Otto Gas Engine Works, Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Marine.

Atlantic Works, East Boston, Mass.

Engines, Stationary.

J. B. Alfree Mfg. Co., Indianapolis, Ind.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
John F. Byers Machine Co., Ravenna, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chandler & Taylor Co., Indianapolis, Ind.
Filer & Stowell Co., Milwaukee, Wis.
Frick Company, Waynesboro, Pa.
Gates Iron Works, Chicago, Ill.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Robert Wetherill & Co., Chester, Pa.

Excavators.

A. B. Bowers, San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.
Willis Shaw, Chicago, Ill.

Fans, Ventilating.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fuel Economizer Co., Matteawan, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Whitlock Coil Pipe Co., Elmwood, Conn.

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Feed-Water Purifiers.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.

Fertilizer Machinery.
Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Filters.
Morison-Jewell Filtration Co., 26 Cortland St., N.Y.

Fire Hydrants.
M. J. Drummond, 192 Broadway, New York.
R. D. Wood & Co., Philadelphia, Pa.

Flexible Shafts.
Chicago Flexible Shaft Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.
Edw. P. Allis Co., Milwaukee, Wis.
Robert Poole & Son Co., Baltimore, Md.

Forges.
Buffalo Forge Co., Buffalo, N. Y.
The Montgomery Company, 105 Fulton St., N. Y.
B. F. Sturtevant Co., Boston, Mass.

Forgings, Iron and Steel.
Chester B. Albree, Allegheny, Penna.

Furnace Builders.
Julian Kennedy, Pittsburg, Pa.

Furniture.
Globe Company, Cincinnati, Ohio.

Furniture and Chair Machinery.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Gages, Pressure, Steam, Water, etc.
Bristol Co., Waterbury, Conn.
The Montgomery Company, 105 Fulton St., N. Y
Walworth Manufacturing Co., Boston, Mass.

Gas Fixtures.
Walworth Manufacturing Co., Boston, Mass.

Gas Holders.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gas Machines and Generators.
American Gas Furnace Co., Elizabeth, N. J.
United Gas Improvement Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Plants.
American Gas Furnace Co., Elizabeth, N. J.
United Gas Improvement Co., Philadelphia, Pa.

Gas Producers.
R. D. Wood & Co., Philadelphia, Pa,
United Gas Improvement Co.. Philadelphia, Pa.

Gas Works Machinery.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gate Valves.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutters.
E. W. Bliss Co., Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Gearing.
Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Jeffrey Mfg. Co., Columbus, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
New Process Rawhide Co., Syracuse, N. Y.
Morse, Williams & Co., Philadelphia, Pa.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Girders.
Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.

Grain Elevator Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.

Grates.
Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Grips, Cable Railways.
Robt. Wetherill & Co., Chester, Pa.

Guns.
Marlin Fire Arms Co., New Haven, Conn.

Hangers.
SEE PULLEYS, ETC.

Heating and Ventilating Apparatus.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
Walworth Manufacturing Co., Boston, Mass.

Hoisting Engines and Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.

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Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Willis Shaw, Chicago, Ill.
Stearns Manufacturing Co., Erie, Pa.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio

Hollow Bricks.

Henry Maurer & Son, 420 E. 23d St., New York.

Hydrants.

R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Cement.

Atlas Cement Co., 143 Liberty St., New York.

Hydraulic Machinery.

Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

The Okonite Co., Ltd., 253 Broadway, N. Y.

Iron.

Passaic Rolling Mill Co., Paterson, N. J.

Joists, Iron and Steel.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Kiers.

Atlantic Works, East Boston, Mass.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

General Electric Co., 44 Broad St., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Link Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Stearns Manufacturing Co., Erie, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Q. & C. Co., Chicago, Ill.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
Stearns Manufacturing Co., Erie, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Strange Forged Twist Drill Co., New Bedford, Mass.
Toledo Machine and Tool Co., Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.
Worcester Machine Screw Co., Worcester, Mass.

Marine Machinery.

Lambert Hoisting Engine Co., Newark, N. J.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc. Philadelphia, Pa.

Merchant Steel.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metals.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Merchant & Co., Inc., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Metal Lath.

Cincinnati Corrugating Co., Piqua, Ohio.

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Metal Punching and Shearing.

Harrington & King Perforating Co., Chaicgo, Ill.

Meters, Electric.

General Electric Co., 44 Broad St., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Meters, Water.

Builders Iron Foundry, Providence, R. I.

Milling Machines.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Mine Cars.

Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.

Mining Machinery

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Mining Screens.

Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.

American Engine Co., Bound Brook, N J.
H. B. Coho & Co., 203 Broadway, New York.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.

American Gas Furnace Co., Elizabeth, N. J.

Nickel.

Canadian Copper Co., Cleveland, O.
Orford Copper Co., 37 Wall St., New York.

Office Furniture.

Globe Company, Cincinnati, Ohio.

Oil Cups.

Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Powell Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Oil Gas Plants.

American Gas Furnace Co., Elizabeth, N. J.

Ore Dressing Machinery.

Cuninghame & Co., Chicago, Ill.

Ore Roasting Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.

Ornamental Iron Work.

Chester B. Albree, Allegheny, Penna.
Winslow Bros. Co., Chicago, Ill.

Packing.

Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., N. Y.
H. W. Johns Mfg Co., New York.
The Montgomery Company, 105 Fulton St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Paints.

Detroit Graphite Mfg. Co., Detroit, Mich.
H. W. Johns Mfg. Co., New York.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paper Mill Machinery.

Jeffrey Mfg. Co., Columbus, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Patents.

Munn & Co., 361 Broadway, New York.

Pattern Makers Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Penstocks.

Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).

Harrington & King Perforating Co., Chicago, Ill.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.

Queen & Co., Inc., Philadelphia, Pa.

Pipe, Cast Iron.

M. J. Drummond, 192 Broadway, New York.
Jeanesville Iron Works, Jeanesville, Pa.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.

National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.

Michigan Pipe Co., Bay City, Mich.

Pipe Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Walworth Manufacturing Co., Boston, Mass.

Pipe Dies.

Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast Iron.

Walworth Manufacturing Co , Boston, Mass.

Pipe, Spiral Riveted.

Abendroth & Root Mfg. Co., 28 Cliff St., N. Y.

Pipe, Wrought Iron.

Walworth Manufacturing Co., Boston, Mass.

Planers.

Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

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Planing Mill Machinery.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Plumbers Tools and Supplies.
Walworth Manufacturing Co., Boston, Mass.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Portland Cement.
Atlas Cement Co., 143 Liberty St., New York.

Power Hammers.
E. W. Bliss Co., Brooklyn, N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.

Power Punches and Shears.
E. W. Bliss Co., Brooklyn, N. Y.
Hilles & Jones Co., Wilmington, Del.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
Stiles & Fladd Press Co., Watertown, N. Y.
R. D. Wood & Co., Philadelphia, Pa,

Power Transmission Machinery.
Filer & Stowell Co., Milwaukee, Wis.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co , Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic, Etc.
Niles Tool Works, Hamilton, Ohio.
Stiles & Fladd Press Co., Watertown, N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Prospecting Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Covers.
Shultz Belting Co., St. Louis, Mo.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.

Pumps and Pumping Machinery.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Filer & Stowell Co., Milwaukee, Wis.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Gates Iron Works, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Wm. E. Quimby, 120 Liberty St., New York.
Willis Shaw, Chicago, Ill.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Quarrying Machinery.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, N. Y.
Willis Shaw, Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens
Harrington & King Perforating Co., Chicago, Ill.

Radiators.
H. B. Smith Co., 137 Center St., N. Y.

Railroad Ditchers.
Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Railway Car Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railway Feed Wires.
The Okonite Co., Limited, 253 Broadway, N. Y.

Railway Shop Machinery.
Chester B. Albree, Allegheny, Penna.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Flexible Shaft Co., Chicago, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Q. & C. Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

Railway Specialties.
Harrington & King Perforating Co., Chicago, Ill.
H. K. Porter & Co., Pittsburg, Pa.
Q & C Co., Chicago, Ill.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.
C. W. Hunt Co., 45 Broadway, N. Y.

Rawhide Pinions.
New Process Rawhide Co., Syracuse, N. Y

Reducing Valves.
Ross Valve Co., Troy, N. Y.

Refrigerating Machinery.
Frick Company, Waynesboro, Pa.

Riveting Machines.
Chester B. Albree, Allegheny, Penna.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.
D. R. Wood & Co., Philadelphia, Pa.

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Road-Making Machinery.

O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Road Rollers.

O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.
Willis Shaw, Chicago, Ill.

Rock Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Rolling Mill Machinery.

Robert Poole & Son Co., Baltimore, Md.

Roofing.

Berlin Iron Bridge Co., East Berlin, Conn.
Cincinnati Corrugating Co., Piqua, Ohio.
H. W. Johns Mfg. Co., New York.
Merchant & Co., Inc., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.

Roofs, Iron, Truss.

Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Rope Transmission.

C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Phila. Pa.,

Rubber Goods.

Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Rust Preventive.

Marlin Fire Arms Co., New Haven, Conn.

Saw Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Chandler & Taylor Co., Indianapolis, Ind.
Filer & Stowell Co., Milwaukee, Wis.

Schools.

Bliss School of Electricity, Washington, D. C.
Columbia University, New York.
Correspondence School of Technology, Cleveland, Ohio.
International Correspondence Schools, Scranton, Pa.
Lehigh University, South Bethlehem, Pa.
Michigan College of Mines, Houghton, Mich.
Purdue Univerity, La Fayette, Ind.
Rose Polytechnic Institute, Terre Haute, Ind.

Screens, Mining.

Gates Iron Works, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.

Harrington & King Perforating Co., Chicago, Ill.

Screw Machines.

Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
The Montgomery Company. 105 Fulton St., N. Y.
Niles Tool Works, Hamilton, Ohio.

Separators, Coal and Ore.

F. D. Cummer & Son Co., Cleveland, Ohio.

Separators, Steam.

Harrison Safety Boiler Works, Philadelphia, Pa.

Shafting.

SEE PULLEYS, ETC.

Shaping Machines.

Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Sheet Metal Statuary.

W. H. Mullins, Salem, Ohio.

Sheet Metal Tools.

E. W. Bliss Co., Brooklyn, N. Y.
Stiles & Fladd Press Co., Watertown, N. Y.
Toledo Machine and Tool Co., Toledo, Ohio.

Shoes and Dies.

Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Smokestacks.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.

Spark Guards, Perforated.

Harrington & King Perforating Co., Chicago.

Steam Regulating Appliances.

Detroit Lubricator Co., Detroit, Mich.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Wm. Powell Co., Cincinnati, Ohio.
Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Steamships and Tow Boats.

Atlantic Works, East Boston, Mass.

Steam Shovels.

Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.

American Blower Co., Detroit, Mich.
American Impulse Wheel Co., of New York, 120 Liberty St., N. Y.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Steel Importers.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Passaic Rolling Mill Co., Paterson, N. J.

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Stokers.

Wm. Sellers & Co., Incorp., Philadelphia, Pa.

Storage Batteries.

Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.

Chester B. Albree, Allegheny, Penna.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Sugar House Machinery.

R. D. Wood & Co., Philadelphia, Pa.

Surveying Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc, Philadelphia, Pa.

Tanks, Iron.

Atlantic Works, East Boston, Mass.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Pittsburg Locomotive Works, Pittsburg, Pa.

Telegraph Wires and Cables.

John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa.

Thermometers.

Bristol Co., Waterbury, Conn.
Queen & Co., Inc., Philadelphia, Pa.

Tie Plates.

Q & C Co., Chicago, Ill.

Tin.

Merchant & Co., Inc., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.

Tin Plate Rolling Machinery.

Robert Poole & Son Co., Baltimore, Md.

Tramways.

C. W. Hunt Co., 45 Broadway, N. Y.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway N. Y.

Turbines.

American Impulse Wheel Co. of New York, 120 Liberty St., N. Y.
James Leffel & Co., Springfield, Ohio.
Robert Poole & Son Co., Baltimore, Md.
R. D. Wood, & Co., Philadelphia, Pa.

Turn Tables.

Passaic Rolling Mill Co., Paterson, N. J.
Wm. Sellers & Co., Philadelphia, Pa.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Strange Forged Twist Drill Co., New Bedford, Mass.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.

Valves, Gas, Steam, and Water.

Detroit Lubricator Co., Detroit, Mich.
Jeanesville Iron Works, Jeanesville, Pa.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
The Montgomery Company, 105 Fulton St., N. Y.
Wm. Powell Co, Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
R. D. Wood & Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Ventilating Appliances.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co, Chicago, Ill.
Merchant & Co., Inc., Philadelphia, Pa.
Pancoast Ventilator Co., Inc., Philadelphia, Pa.
B. F. Sturtevant Co., Boston, Mass.

Voltmeters.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Ins. Co., Newark, N. J.

Water Meters.

Builders Iron Foundry, Providence, R. I.

Water Works Supplies.

American Well Works, Aurora, Ill.
McNeal Pipe and Foundry Co., Burlington, N. J.

Water Wheels.

American Impulse Wheel Co. of New York, 120 Liberty St., N. Y.
Dayton Globe Iron Works Co., Dayton, Ohio.
James Leffel & Co., Springfield, Ohio.
Robert Poole & Son Co., Baltimore, Md.
R. D. Wood & Co., Philadelphia, Pa.

Well Sinking Machinery.

American Well Works, Aurora, Ill.

Window Guards (Jail Work).

Harrington & King Perforating Co., Chicago, Ill.

Wire.

Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

Jeffrey Mfg. Co., Columbus, Ohio.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wood-Working Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Worm Gears.

Morse, Williams & Co., Philadelphia, Pa.

Wrecking Cars.

Marion Steam Shovel Co., Marion, Ohio.

Yachts, Steam.

Atlantic Works, East Boston, Mass.

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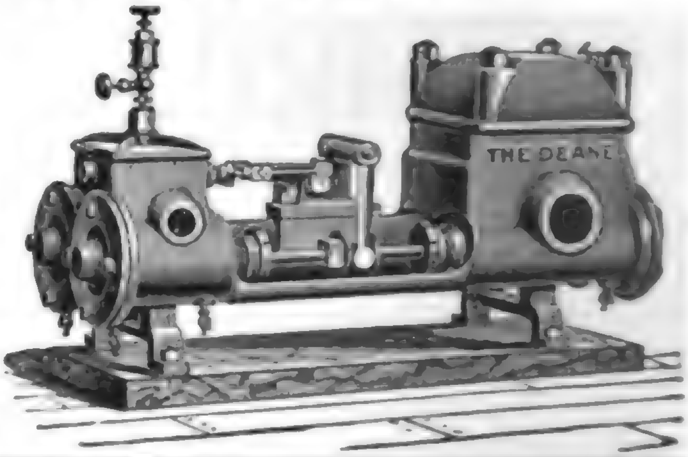

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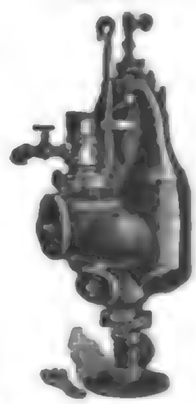

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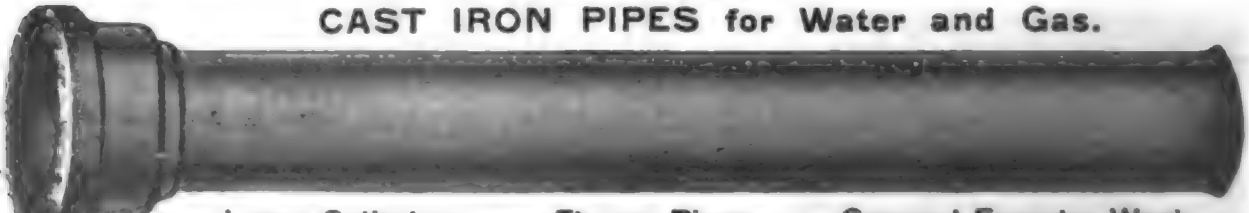

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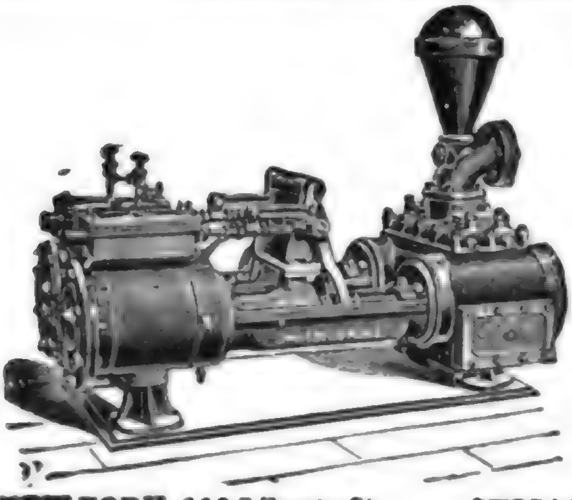

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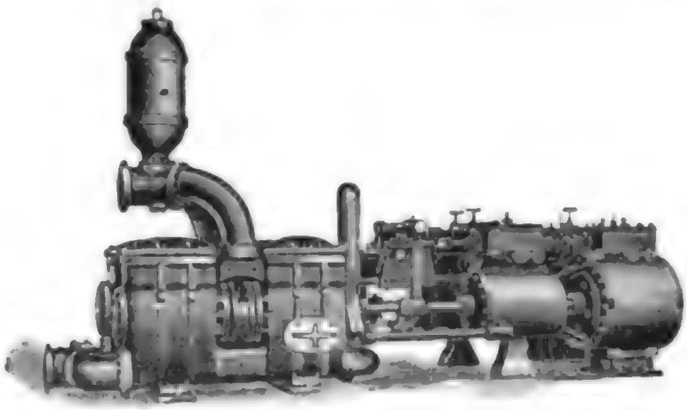

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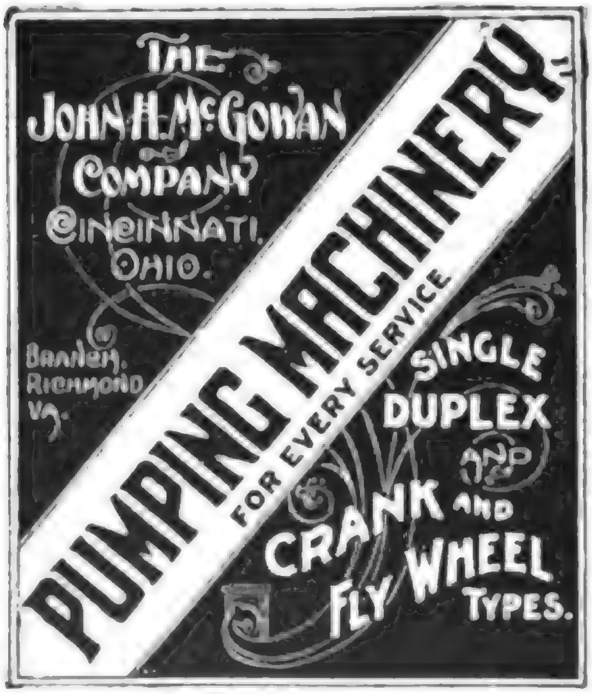

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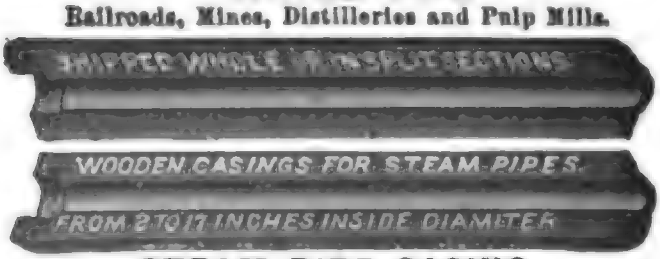

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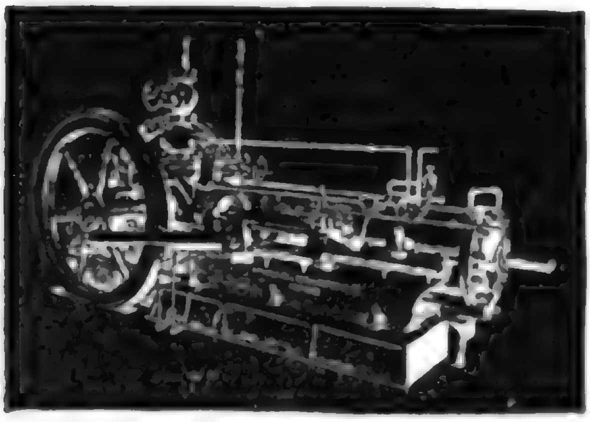

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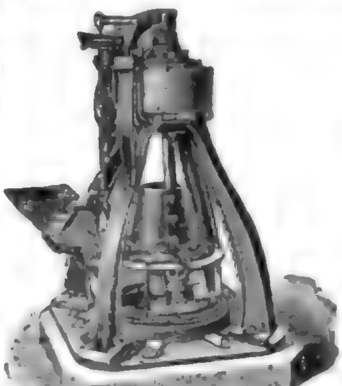

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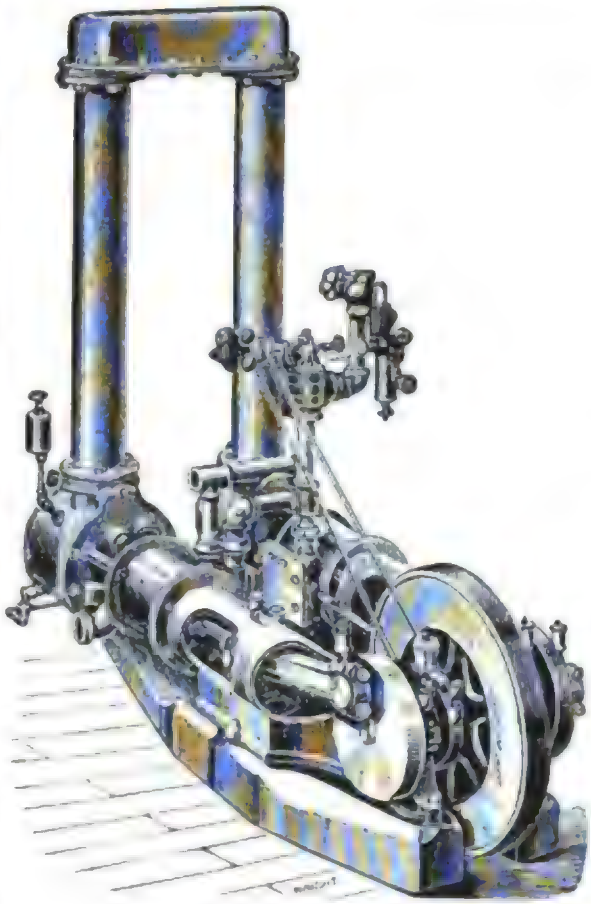

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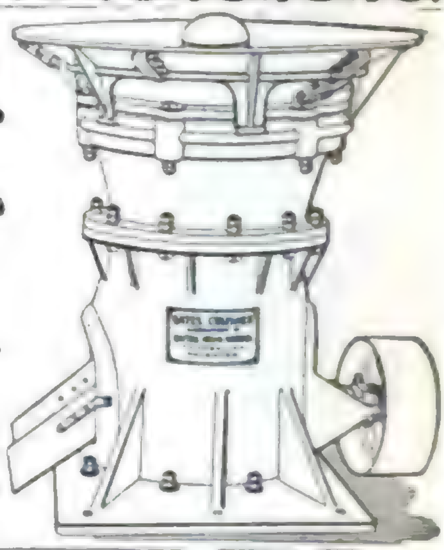

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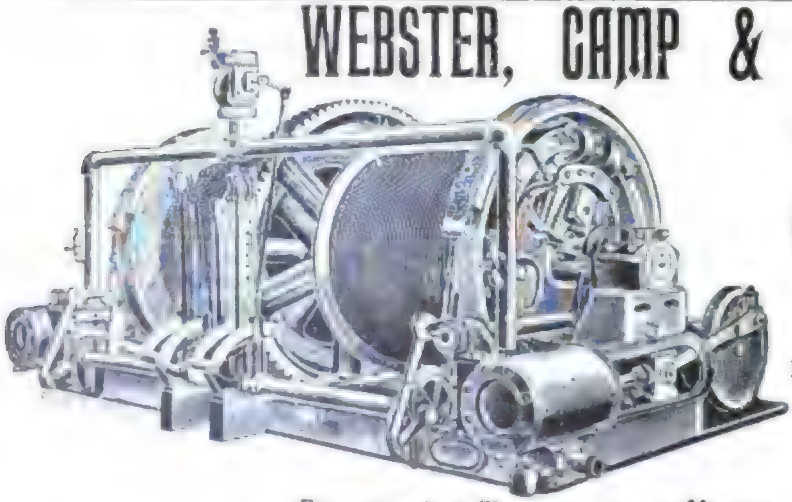

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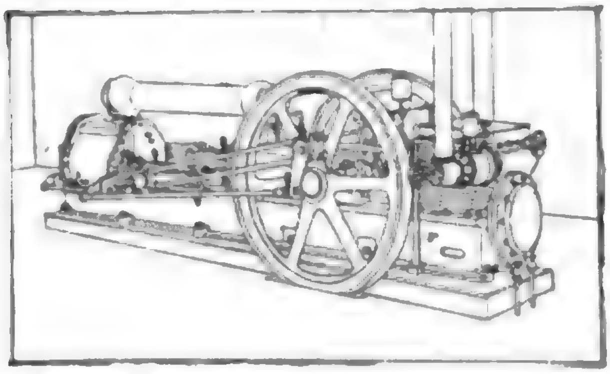

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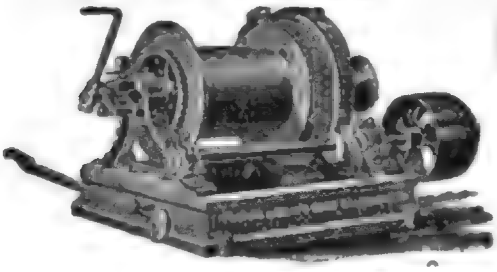

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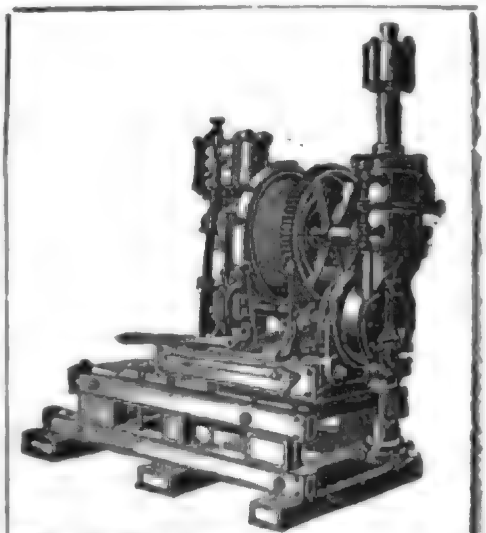

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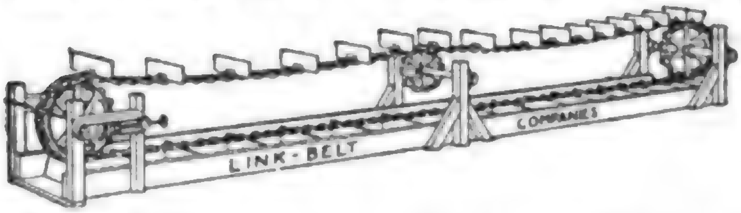

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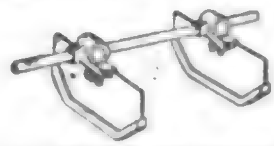

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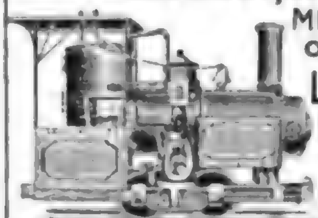

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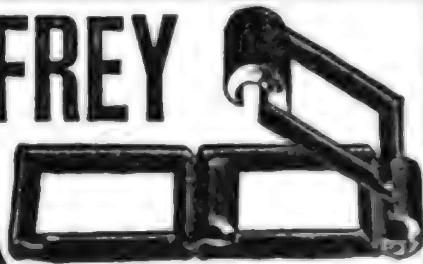

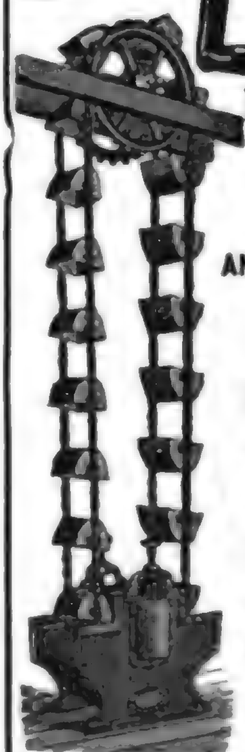

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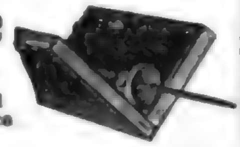

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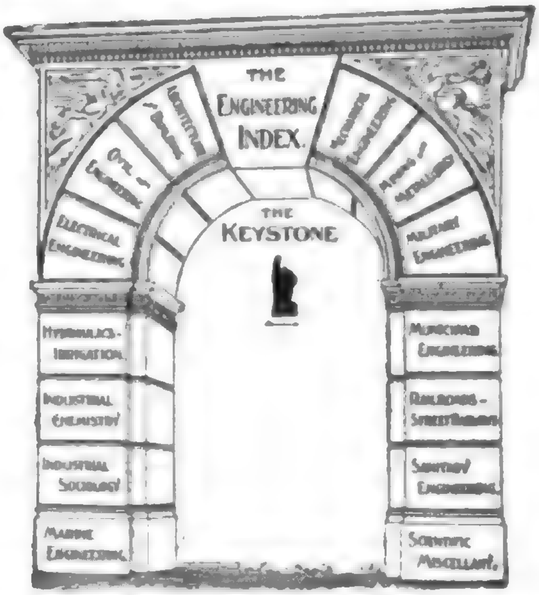

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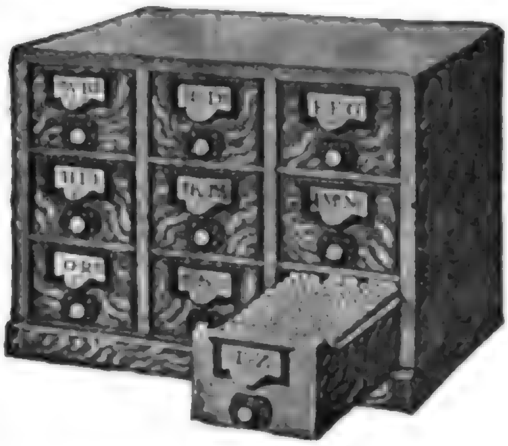

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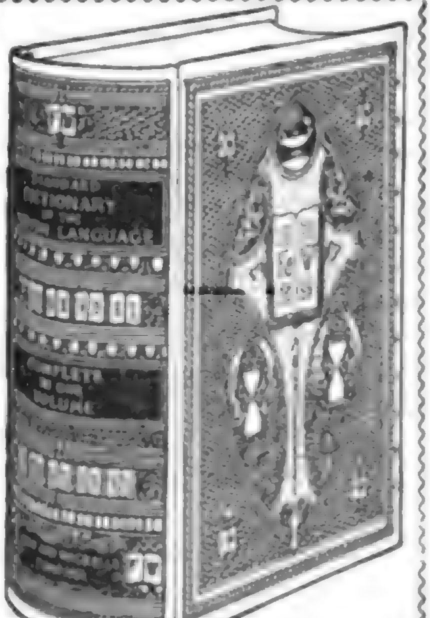

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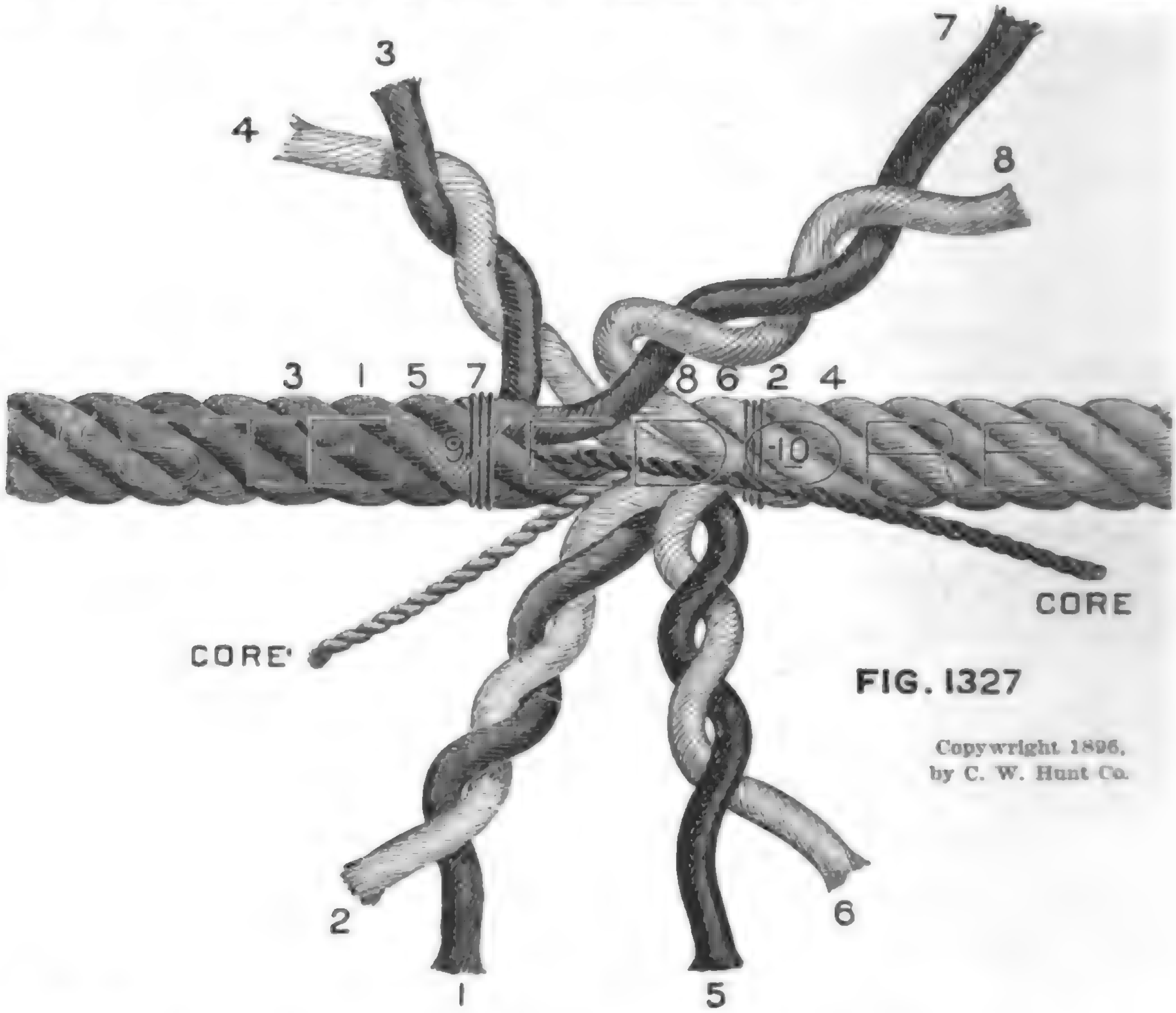

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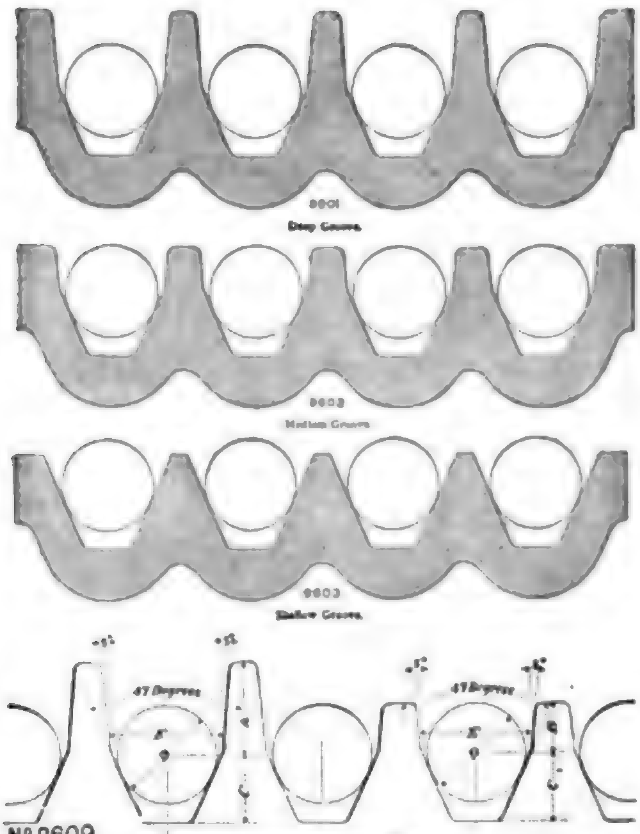

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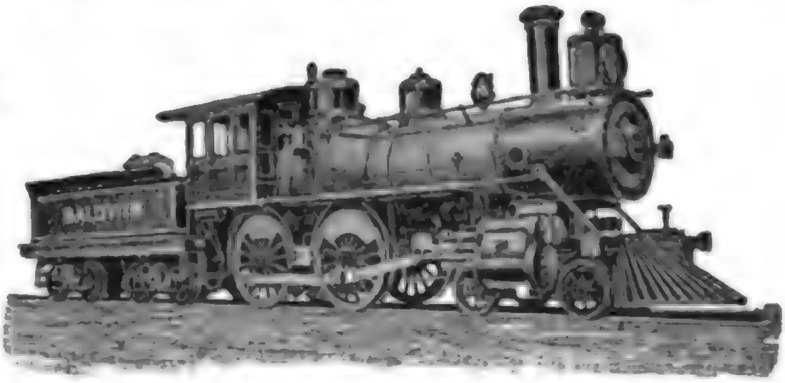

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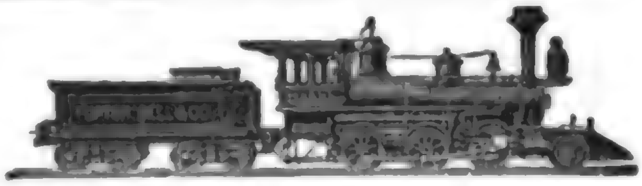

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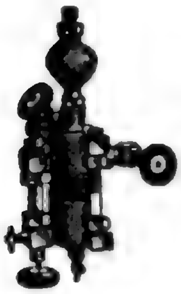

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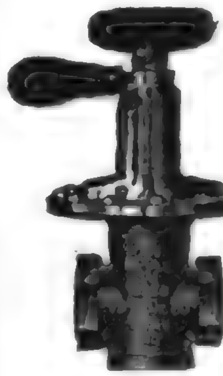

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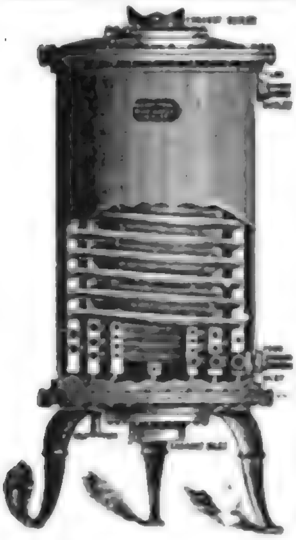

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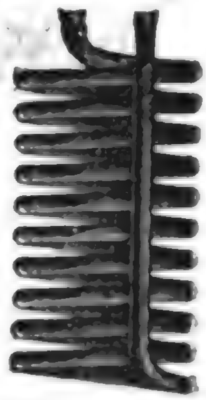

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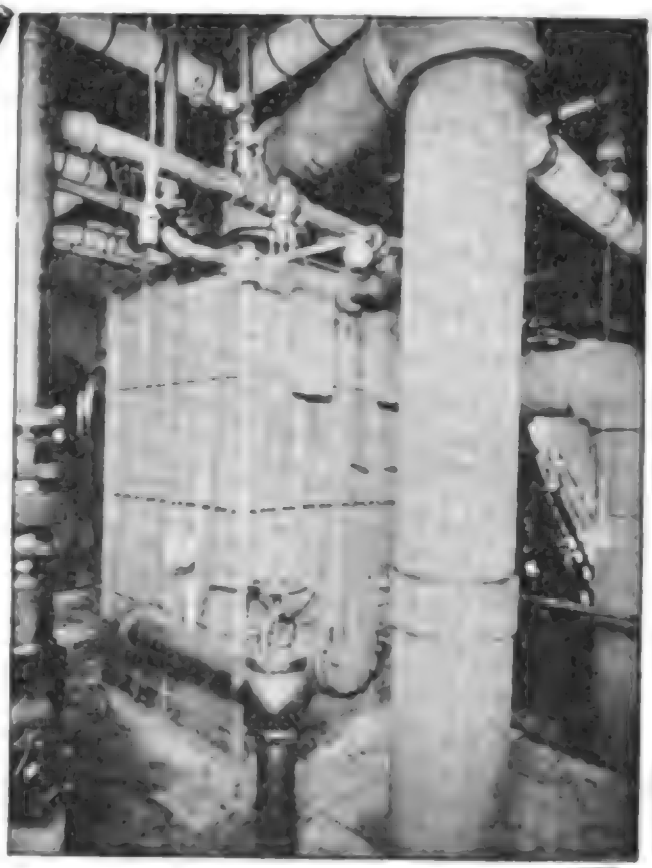

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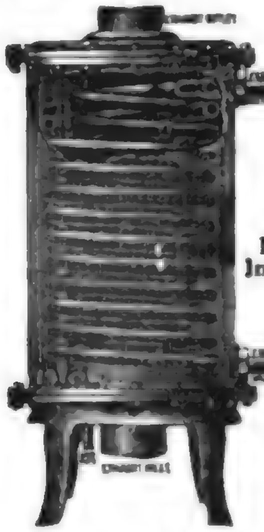

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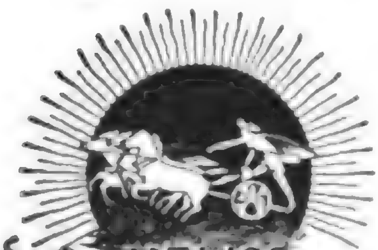

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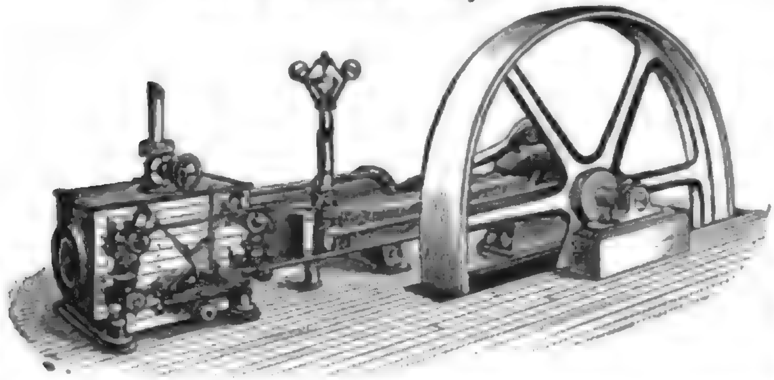

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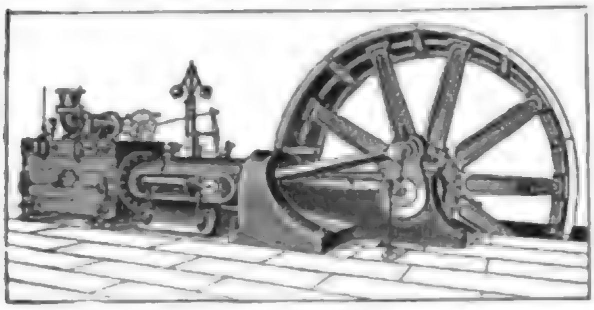

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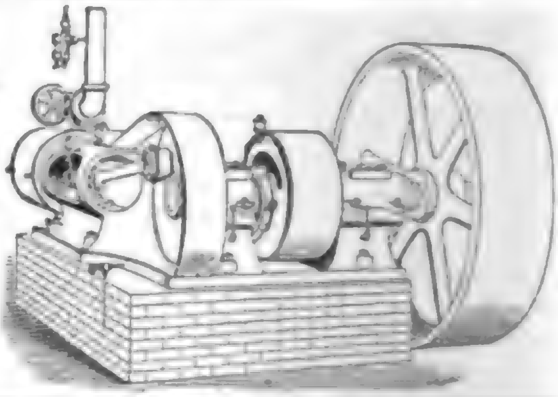

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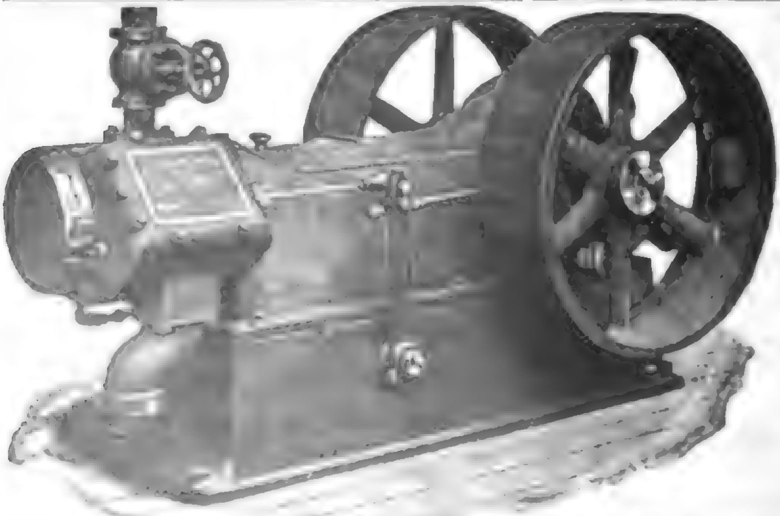

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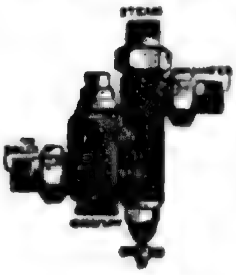

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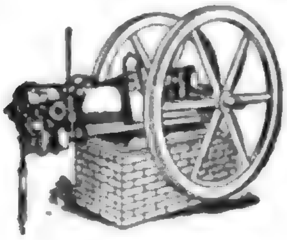

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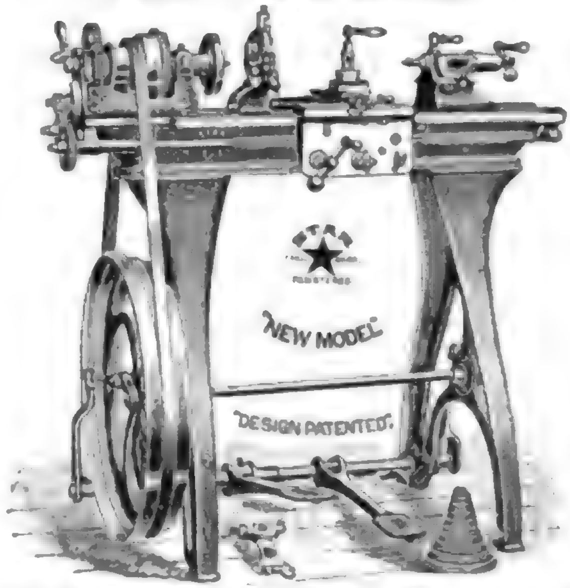

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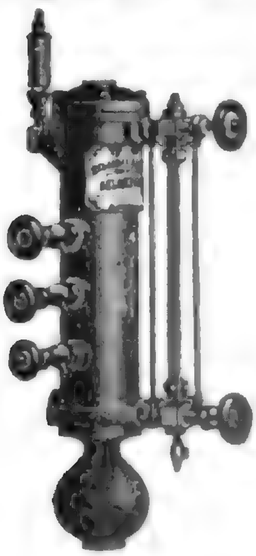

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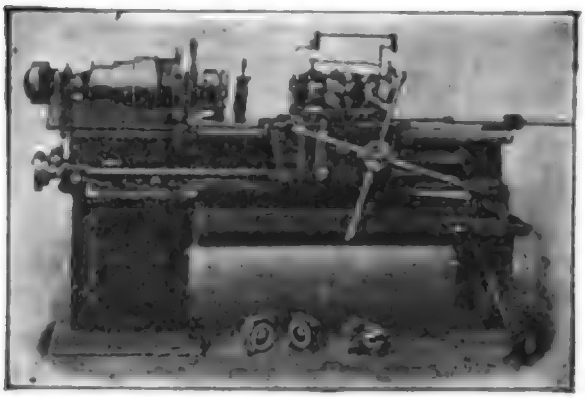

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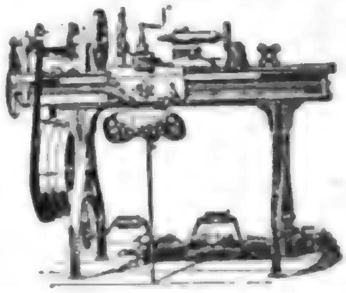

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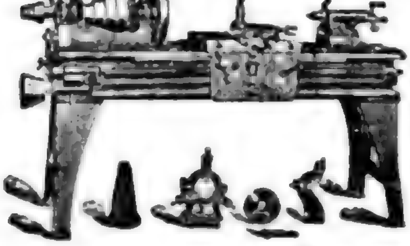

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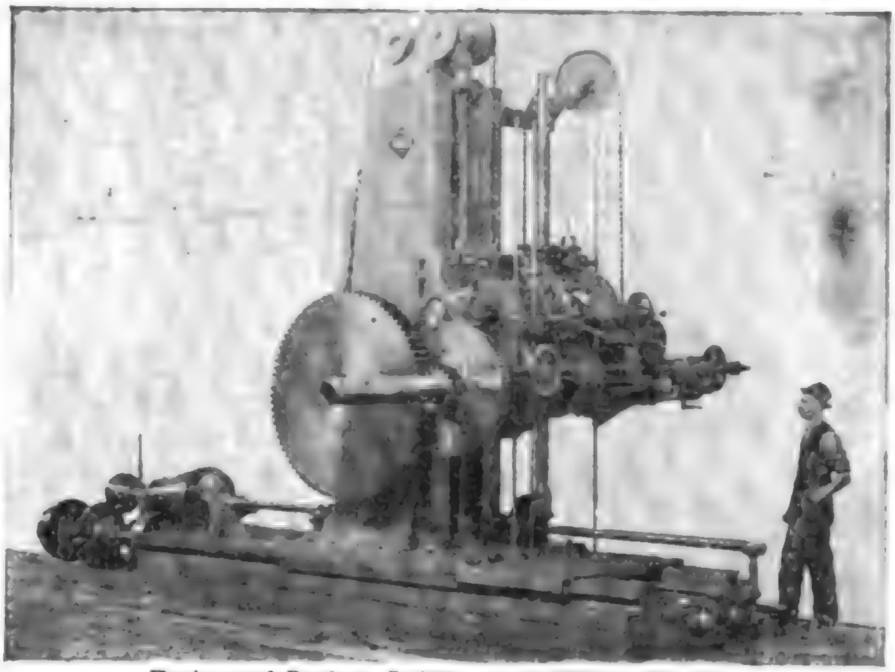

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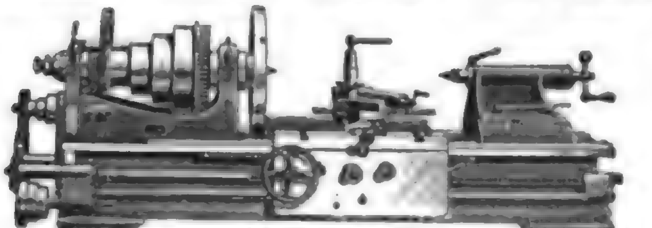

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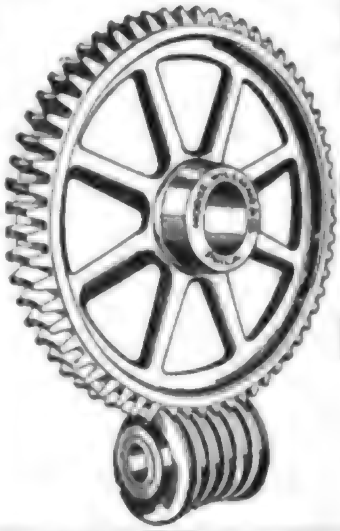

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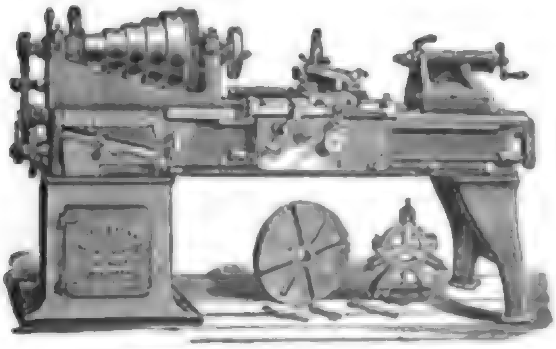

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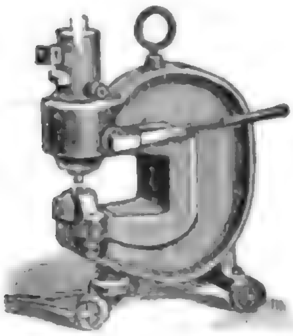

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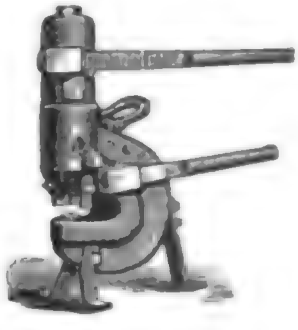

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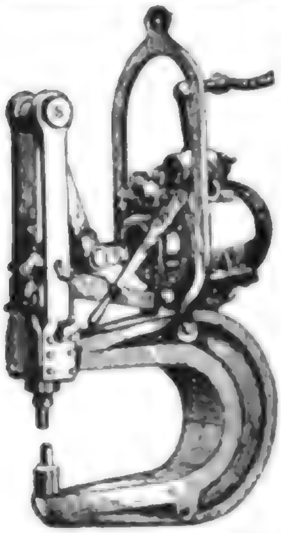

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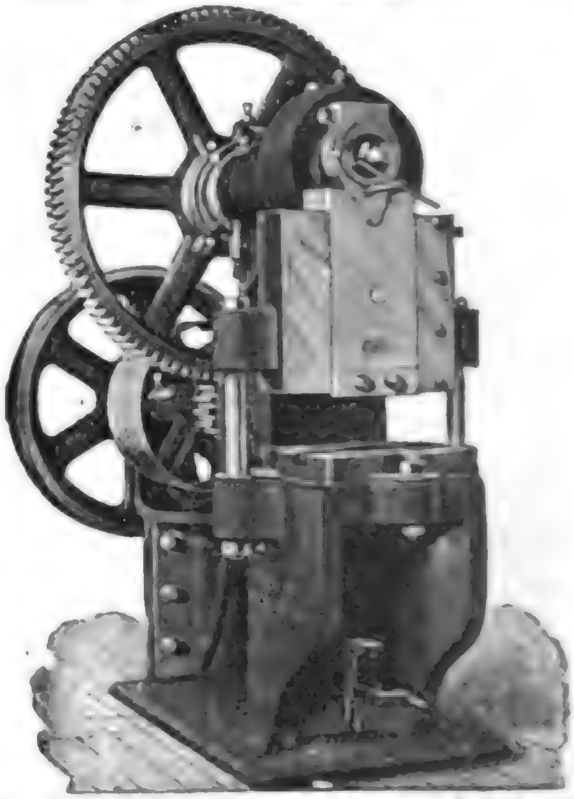

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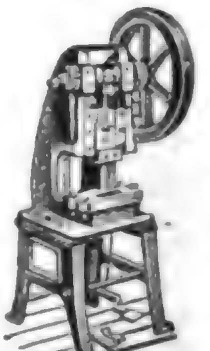

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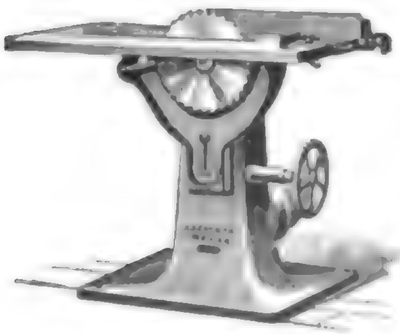

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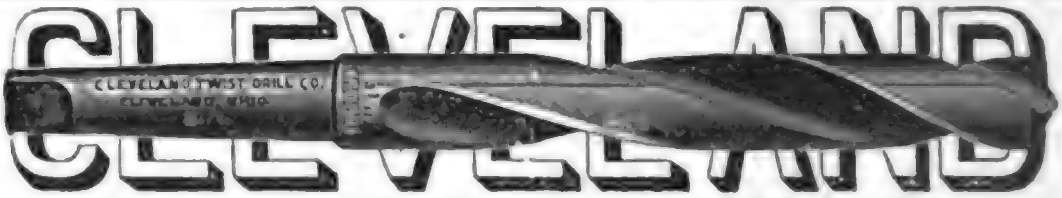

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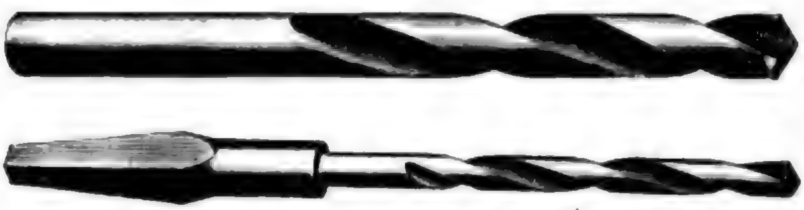

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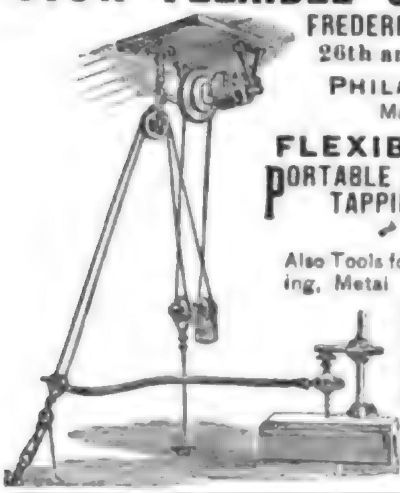

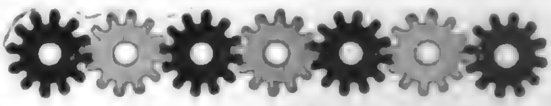

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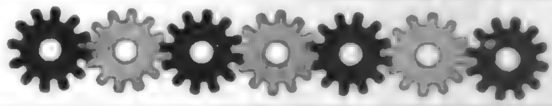

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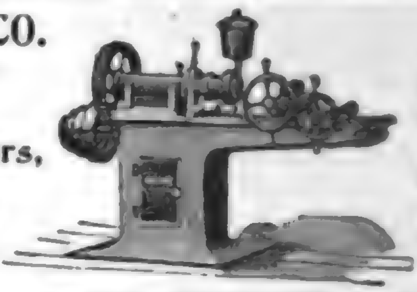

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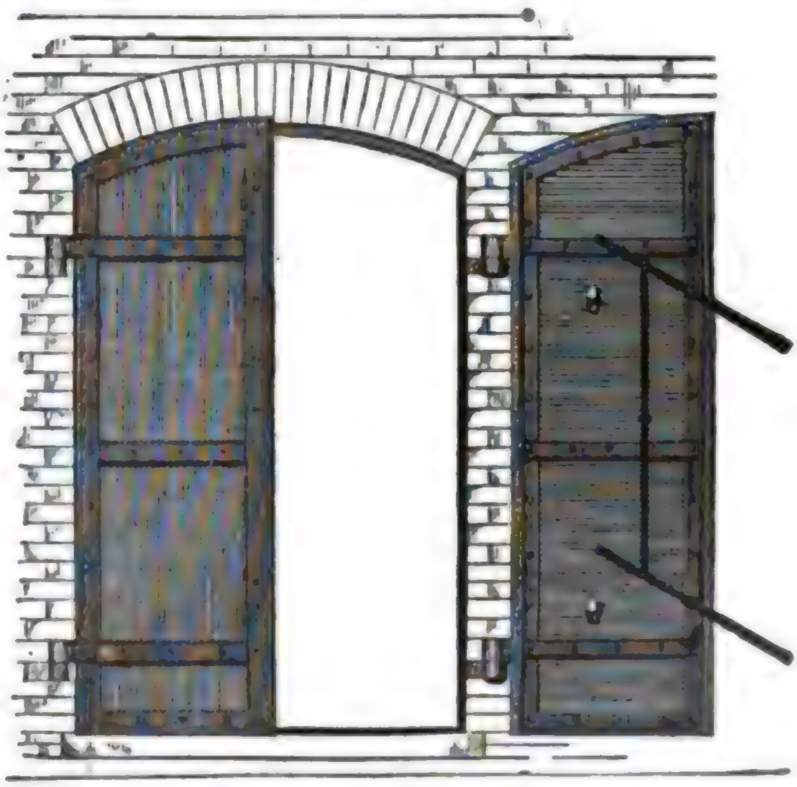

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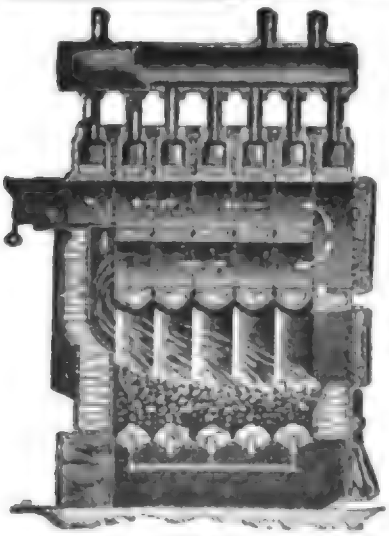

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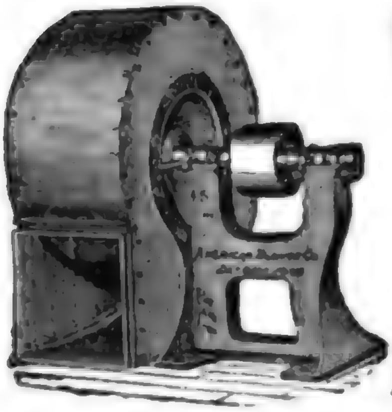

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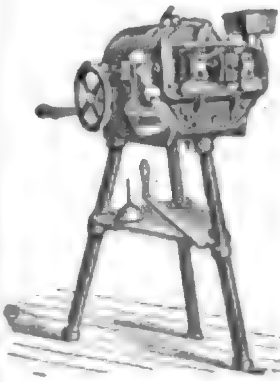

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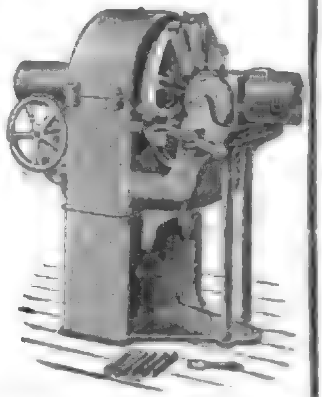

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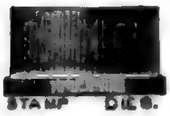

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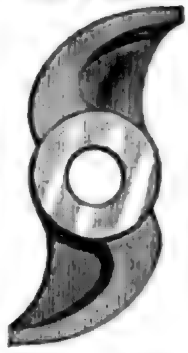

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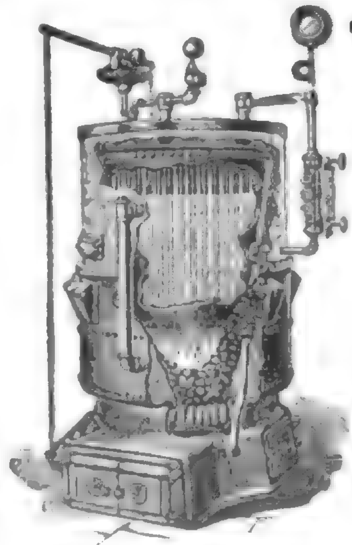

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AN INDUSTRIAL REVIEW

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FOR INTRODUCTION TO AUTHORS, SEE PAGE 5.

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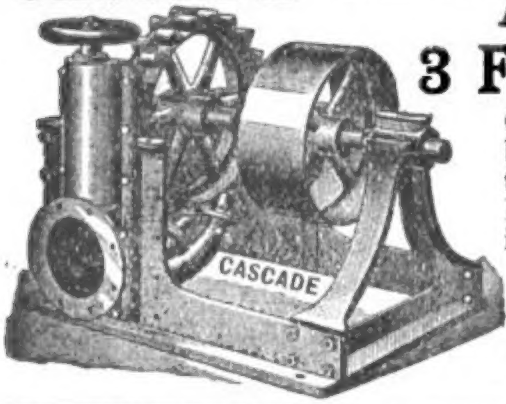
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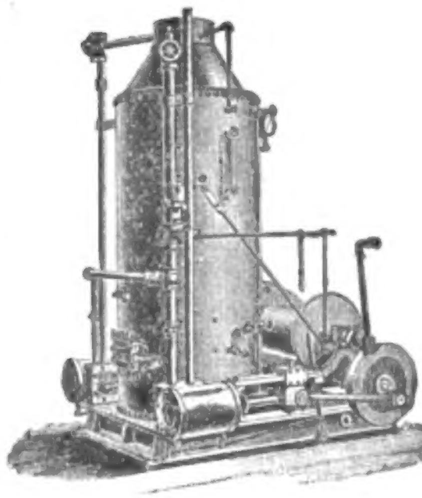

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